JOURNAL

OF THE

FRANKLIN INSTITUTE

OF THE STATE OF PENNSYLVANIA

FOR THE PROMOTION OF THE MECHANIC ARTS

VOL. CLXIII, NO. 1 82ND YEAR JANUARY, 1907

The Franklin Institute is not responsible for the statements and opinions advanced by contributors to the *Journal.*

Mechanical and Engineering Section.

(Stated meeting held Thursday, December 13th, 1906.)

The Art of Manufacture of Railway Car Axles.

BY HENRIK V. VON Z. LOSS, M.E.,

M. Am. Soc. M. E. Member of the Institute.

Mr. Chairman and Members of the Institute:

It was my good fortune to have been associated with the birth of the steel car, once an experiment, which quickly, however, became a standard. As the Consulting Mechanical Engineer of the Pressed Steel Car Company, I designed practically all of their plants as well as assisted materially in developing the different details of car construction. I had the pleasure of presenting this work to the railway profession of the world at a meeting of the International Railway Congress, held in Paris in 1900. The increase from the old 60,000 or

highest 80,000 lbs. car capacity to one of 55 tons suggested the necessity of having to overcome another difficulty that was encountered, namely, the weakness of the flange in the present cast-iron wheel. In a lecture delivered in February, 1904, I had the honor of laying before this Institute my work in that field. The solid forged and rolled steel wheel, which at that time was a mere experiment, is now a standard adopted by several of our leading trunk lines, one of these having only a few months ago placed an order for 70,000 wheels of this type. With the car and its wheels thoroughly strengthened and modernized, it occurred to me that the one remaining vital detail, viz: the axle, had a right to some consideration.

With the car axle the case is somewhat different from that presented by the car wheel. The old cast-iron wheel was decidedly too weak and the substitution of steel-tired ones was too expensive. Both facts had to be met and solved. The present axles, of course, do break, but not to the same extent as the present cast-iron wheels. However, when considering the required long life of a car axle and the comparative short period—about six to seven years—since the introduction of the 55-ton capacity steel car, we must admit that old statistics must be revised before we can with any reliability tabulate the total fractures of axles, which we from now on shall have to face. On this account I always felt that an axle somewhat stronger than the present standard should be the coming type. But secondly, and mainly, the method of manufacture as now in vogue is decidedly unfinished and crude, involving large wastes, both in material and labor. In order to more fully appreciate the present condition of this art, both as to method pursued and quality produced, I shall describe more in detail the manner used in the making of the standard axle of to-day.

A square billet, with about 7″ to 8″ sides, coming as a product of the blooming or billet mill, is the shape in which the metal reaches the axle shop. There it is heated and afterwards placed under a hammer, having generally a crew of three men and one boy, where the horizontally split semicircular dies are attached to the anvil block and to the ram. Three sets of dies are generally placed side by side, but in one block, roughing and finishing dies, the latter consisting of a pair of tapering and a pair of journaling dies, and the time consumed by the

hammering process varies with the size of product, averaging during a day's run, about fifteen minutes for a 5½" x 10" journal axle, this dimension being the one used for a 55-tons capacity car. After the hammering does come or should come the annealing process, not always indulged in, however: then the straightening, now very often omitted with the large axles on account of their great resistance. The next step is the cutting off the rough ends in separate machines, followed by the drilling of the ends or centering, so as to enable the turning lathes to receive them, and here they are now rough-turned, or brought down to sizes, leaving only about 1-16" to be taken off in the finishing lathes at journals, dust guard seats and wheel fits, and in which machines the journals are also polished.

When in forging steel the material is rapidly finished from a high working heat, the grain remains coarse and open with impaired ductility and resisting strength. Hence, it is desirable to continue the forging process until the temperature of the piece falls below 1200° F. The structure of the metal and its endurance under working stresses are much improved by a final heat treatment or annealing. This is accomplished by uniformly reheating the finished forging after it has cooled sufficiently (certainly below 1200° F.) up to a temperature of 1500 to 1800° F.,—the higher temperature having proved the most effective, and then cooling down uniformly.

With the above in view the matter of annealing axles becomes of considerable importance and, while only occasionally specified, this step in the process should not be omitted if a high-grade product is desired. The annealing can be economically accomplished by rolling the axles through a continuous furnace having a heated center, being somewhat similar to the furnace used in annealing glass. The rolling prevents the tendency to warp, which otherwise would occur if a bar is cooled unevenly on two sides, and the mechanical construction involved is the simple problem of slow rolling on a pair of cooling rails.

The manufacture of railway car axles represents a very considerable tonnage. During the year 1904, which was one of decidedly dull business activity, the railroads adding hardly any cars to their rolling stock, the total output in this country was about 90,000 tons, of which amount the United States Steel

Corporation furnished about 63,000 tons. The year 1905, on the other hand, was one of very great activity, the United States Steel Corporation alone furnishing 150,000 tons. Based upon the same ratio, the total product of the country should then have been about 225,000 tons of axles. The greater part of this product represents new rolling stock, the remainder being renewals of axles on old cars. Assuming three to four axles per ton, the above total would mean the building and refitting of from 150,000 to 200,000 railroad cars in one year.

The material used in car axles is steel, with an amount of carbon that has been considerably increased in later years. As an illustration, I herewith attach the chemical specification of the Penn. R. R. for their axles:—

Carbon	0.40 per cent.
Manganese, not above	0.50 "
Silicon	0.05 "
Phosphorus, not above	0.05 "
Sulphur, not above	0.04 "

This same road considers the axle to have failed chemically if the analysis of the borings give figures for the various constituents outside of the following limits:—

Carbon	below 0.33 or above 0.50 per cent.
Manganese	above 0.60 "
Phosphorus	above 0.07 "

The main physical test of an axle is that of the drop. The standard Penna. drop test involves the following essential parts:—

The points of supports on which the axle rests during the test must be three feet apart from center to center; the tup must weigh 1640 pounds; the anvil which is supported on springs must weigh 17,500 pounds; it must be free to move in a vertical direction; the springs on which it rests must be twelve in number of the kind described in P. R. R. specifications, and the radius of the supports and of the striking face on the tup in the direction of the axis of the axle, must be 5 inches. When an axle is tested it must be so placed in the machine that the tup will strike it midway between the ends, and it must be turned over after the first and third blows, and when required, after the fifth blow. After the first blow the deflection of the axle under test will be measured.

The different car axles used by this road are each and all required to stand at least five blows without rupture, with a height of drop varying from 28½ feet up to 43 feet, showing deflections of from 6 to 7¼ inches after the first blow. Separate from the above, the new 5½″ x 10″ journal axle, which is used for the 55-ton steel cars, shall stand seven blows, with a 43-feet drop and a 4½-inch limit of deflection after the first blow.

The above first-named axles will be rejected if, with the number of blows already stated, they rupture or fracture in any way or if the deflections exceed from 7 to 8¼ inches respectively. With a 5½″ × 10″ journal axle, the deflection must not exceed 5½ inches after first blow.

Some railroads are satisfied with having their axles turned only on journals, dust guard seats and wheel fits, leaving the remainder as it comes from the hammer, while others, as for instance, the Pennsylvania, requires rough turning from end to end, with the subsequent finishing on wheel fits, dust guard seats and journals. I believe the Pennsylvania's method is correct, when considering the present crude manner of making an axle under the hammer. The rough forging leaves the product very much unbalanced. I have seen as much as half an inch or more cut off the radius of the axle on one side, with the tool but little more than touching on the other. There has also been an assertion made that the metal needs inspection fro mend to end, requiring turning to do so.

On the other hand if a car axle could be forged entirely smooth between wheel-seats with little or no expense, there is no doubt as to the value of the tough surface skin in withstanding the severe alternating stresses, and as to the necessity of rough turning for the sake of inspection, the general results with the railroads of the country do not seem to bear out that assertion, when considering that the vast majority of axles inspected, passed and successfully run are rough between the wheel-seats. While on this particular subject I shall quote the following from an address delivered a couple of years ago by Mr. J. L. Replogle, of the Cambria Steel Co., before the Western Railway Club in Chicago:

"During a controversy with an inspector of a prominent railroad which specifies rough turning all over, we suggested to him that he take two axles of the same heat, one being

rough-turned to $5\frac{7}{8}$ inches in center, the other being smooth forged to same dimension. These axles were subjected to the same treatment throughout and were then tested to breakage. The rough-turned axle stood 21 blows of a 1640-pound drop from 43 feet height, and the smooth forged one stood 78 blows, or almost four times as severe a test.

"Tensile tests cut from the two broken axles showed the same chemical and physical structure.

"Extensive tests made at another works by one of the leading railroads specifying this, show that in axles of the average carbon, the smooth forged axle will stand approximately 43 per cent. harder test than the rough-turned one. Rough-turning an axle makes it more susceptible to rust."

There are many objections to be raised to the present mode of manufacturing axles and I shall enumerate some of them:

1st. Hammering metal in open dies is a poor method of improving the material. Under each blow of the ram the metal will greatly squash or flow out sideways at each end of the die, leaving imperfect compression on the material. Again, especially with the heavy modern axles, there is only a chance of the hammer-blow reaching the center of the billet, and due to its continuous rotation in the dies while hammering, there is also a tendency towards piping.

2nd. The weakest place in an axle is close to the wheel-seat, as it is here where the maxima stress moments occur. It would be only right under such circumstances, to expect the maximum amount of work to have been placed upon the billet at this point. But the reverse is the fact. The greatest hammering is at the middle and center and the least at the wheel-seat, where the cross-dimensions are more nearly those of the original billet.

3rd. All axles should be annealed, but generally they are not. They also should be straightened so as to avoid waste in rough-turning, but as already mentioned, such is rarely done, especially with the large sizes.

4th. The method of hammering an axle is so crude that in order to produce a decent mechanical product, the waste through turning and in cutting off the ends, becomes very excessive. 15% is quite common, in fact, with axles of moderate sizes this figure is considered good practice.

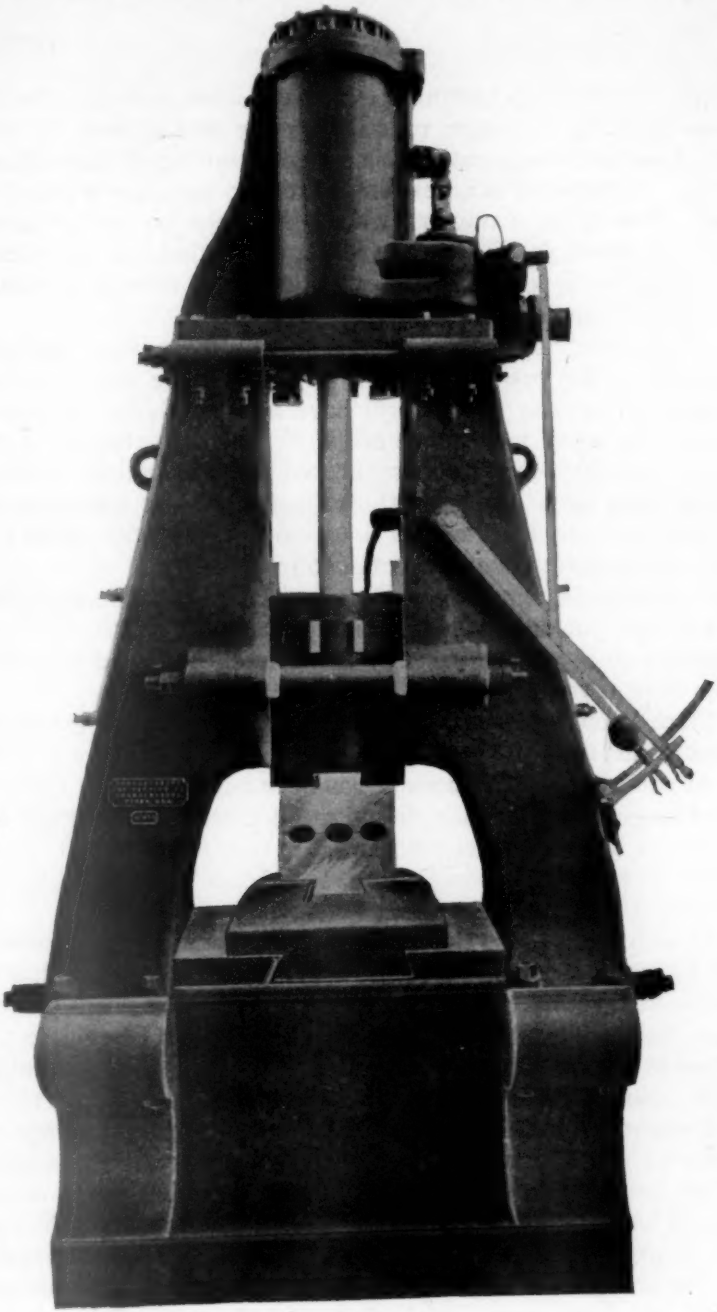


PLATE I

5th. Repairs to hammers is a great item, and the continuous breaking of piston rods is a worry which those of you who have been engaged in this art will thoroughly appreciate.

6th. A hammer is an expensive tool to use from a point of fuel. The latest hammers when operating on heavy axles average about 50 H. P. when in actual service and the steam consumption is one far in excess of what economic steam machinery should require.

I have tried to enumerate some of the most important objections to the present method of axle-making and it is but natural to assume that efforts have been made to overcome them. In order to insure more work on the metal, the Pencoyd Iron Co.—this company ceased the production of axles some years ago—increased the capacity of their hammers up to five tons and I believe six or seven is still better, while the prevailing custom is only from 4000 to 7000 lbs.

One of the leading axle works in the country has recently followed suit, but did not go far enough when doing so, their old hammers of 3500 lbs. capacity being lately followed by a few new ones of 7000 lbs.

Plate I represents a type of the modern hammers generally used in this art.

At some places the hammer has been superseded by the vertical forging press, which should mean a decrease in repair account, as well as in fuel cost, and it is very likely that it would give a product better in texture, and closer to dimensions, resulting in smaller waste.

In order to reduce the amount of work under the hammer, the Carnegie Company several years ago adopted an additional mill, which receives the square billets and breaks down its corners, producing practically an octagon billet to be sent to the hammer. I have been informed that this company has lately gone a step farther and introduced a mill, the product of which is a round bar. Of course, all and any of these processes require additional cost to be added to that of the original square billet, but they thoroughly show the appreciation of the necessity of having to do something. Nor must it be thought that this appreciation has not found an outlet in more radical ways. There are certain objections to the axle-hammering process which are fundamental, as for instance, the want of deep pene-

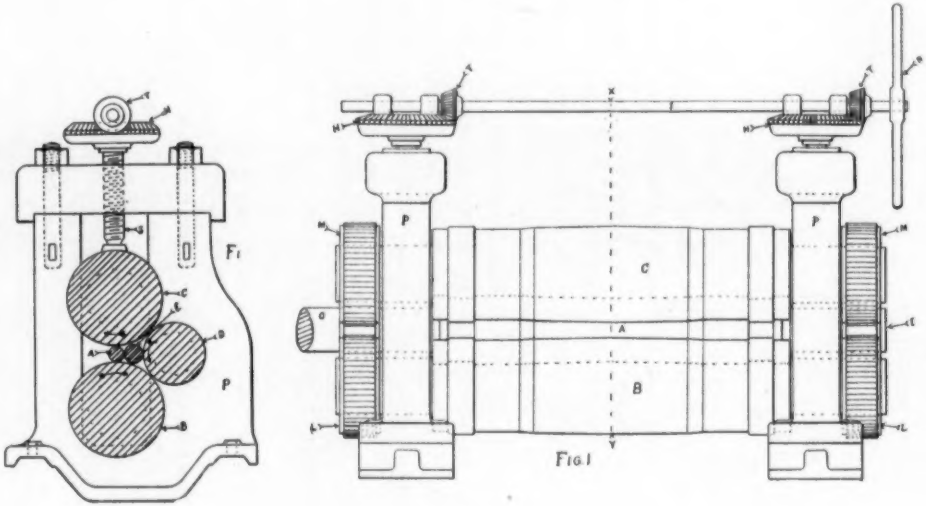


PLATE II

tration by the blow, the expending of a minimum amount of work at and near the wheel-seat, and the large amount of scrap, all of which when taken in connection with the additional cost necessitated by the introduction of extra mills for re-rolling the square billet, have brought about departures quite radical in their methods. First among them I shall mention the efforts to produce an axle by rolling machinery.

This principle has been the subject of many experiments for twenty or more years past and the method pursued was generally one of the following two:—

1st. End rolling, where a round bar is fed endways between a pair of rolls, the grooves of which are cut so as to form an axle in one or more passes, the circumference of each roll being equal to or more than the length of the axle.

2nd. Cross rolling, where the round bar is fed at one time throughout its entire length, into a pair of rolls, the axes of which are parallel to the axle.

The first method presents many practical difficulties, especially on account of the work in each pass having to be finished in one revolution of the rolls. It is more than likely that a hydraulically operated train would be quite preferable to an engine or belt-driven device because of the greater control of its movement. Due to several causes, the experiments proved a failure and the process was abandoned.

The second method has been tried possibly more extensively and I have witnessed some of the results obtained. A number of years ago a mill for this purpose was built at the Pencoyd Works under the patents of Mr. J. R. Jones. Plate II show the principle of the machine. Rolls B, C and D are driven, with roll E as an idler, this latter being supported throughout its entire length by roll D. A is the blank formed into an axle by grooves in rolls B, C and E.

The great objection to this method lies in the bad twisting effect upon the axle caused by the variation in the peripheral speed of each and all of the rolls, due to the different diameters, brought about by the cutting of the grooves. Mr. James Christie, whom we all know, devised then a mechanical scheme to overcome this great defect. It was never tried, however, and the process was afterwards abandoned. All rolling devices presented up to this time possess also in addition to the

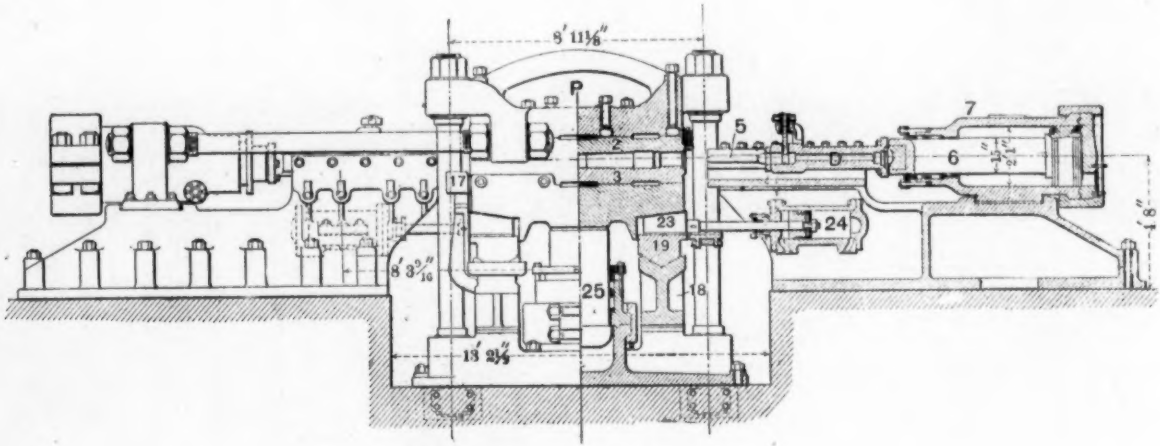


PLATE IV

objections found at the trials the feature, in common with the hammer process, of doing the greatest work on the blank near the middle and the least amount at the wheel-seats, a condition which properly should be reversed. They also require a blank of a circular cross-section.

We shall now consider the next step in the evolution of axle manufacture, viz:—"The Mercader Process."

This method consists in placing a plain, round rolled bar of proper diameter and length in a longitudinally split die, the inner contour of which is that of the finished forging, with the die touching or slightly gripping the blank at its middle and ends. The half-dies are now fastened together, whereupon a long needle (equal to about one-third the length of the complete axle) is pushed against each end of the blank, penetrating it on the center line and forcing the metal sideways—and also slightly longitudinally—so as to completely fill the die, after which the two needles are withdrawn, the dies unlocked and the forging removed for end cutting, centering and turning. It is vital that the blank shall be perfectly straight before being perforated.

Plate III shows the blank and the forged as well as the finished product.

Plate IV shows a cross elevation of the axle press, partly outside view and partly in section. The punching needles, with their operating cylinders, are clearly shown. The die is split on a horizontal line, the upper half being stationary, while the lower half can be dropped and then moved horizontally out of the way for the introduction of the blank and removal of product.

Plates V, VI and VII show a number of these axles, some made and piled and other mounted on wheels.

The value of an axle forged in closed dies has been proved by a series of tests made by the Howard Axle Works in connection with this process and which were embodied in a paper read by Mr. Mercader before the British Iron and Steel Institute. The Pennsylvania Railroad specifications were followed in each instance and the axles were made under temperatures varying from 1500° F. up to 2000° F. Those made at the cooler temperature proved the strongest, requiring over seventy blows for fracture, while those

PLATE V

made at the higher ones required about forty, but it must be added that this test was specially severe, the axle being turned over after each blow, instead of after every blow, as required by the specifications.

A number of these axles were made at the Howard Axle Works at Homestead and a few of them are to-day in service on the Pennsylvania Railroad. The process had several points in its favor:—

1st. It dispensed with the rough-turning, hence doing away with a large amount of scrap.

2nd. It saved the outer skin between wheel-seats, thus adding considerably to the strength of the product.

3rd. The axle was exposed to great pressure throughout its length and cross-section, due to being forged in closed dies, in this way producing a very dense and greatly superior metal.

4th. It was also claimed that by being hollow, the journals would run cooler and that the weight saved—the axle being solid only throughout its middle third—would be of some consideration.

On the other hand, there were some vital objections to its adoption:—

1st. It was found very difficult to guide the needle centrally.

2nd. It became necessary to insert a loose drop forged steel cap over the end of each needle, so as to permit their withdrawal and to prevent the welding together of needle and blank. The caps remained in the axle.

3rd. Due to the great length of the pushing needles, as compared to their diameter, about 9 to 1, there was considerable difficulty in securing punches that would stand the strain and the wear.

4th. Due to the light amount of flow of the steel, the blank had to be a finished round rolled bar. If originally rough, the product would remain rough. The cost of producing such a bar, instead of using an ordinary billet, was a tax on the process.

5th. The heated blank had to pass through a straightening machine before being placed in the axle press.

6th. Some railway officials raised objections to the axle on account of the large hole, $3\frac{1}{4}$ inches in diameter, which repre-

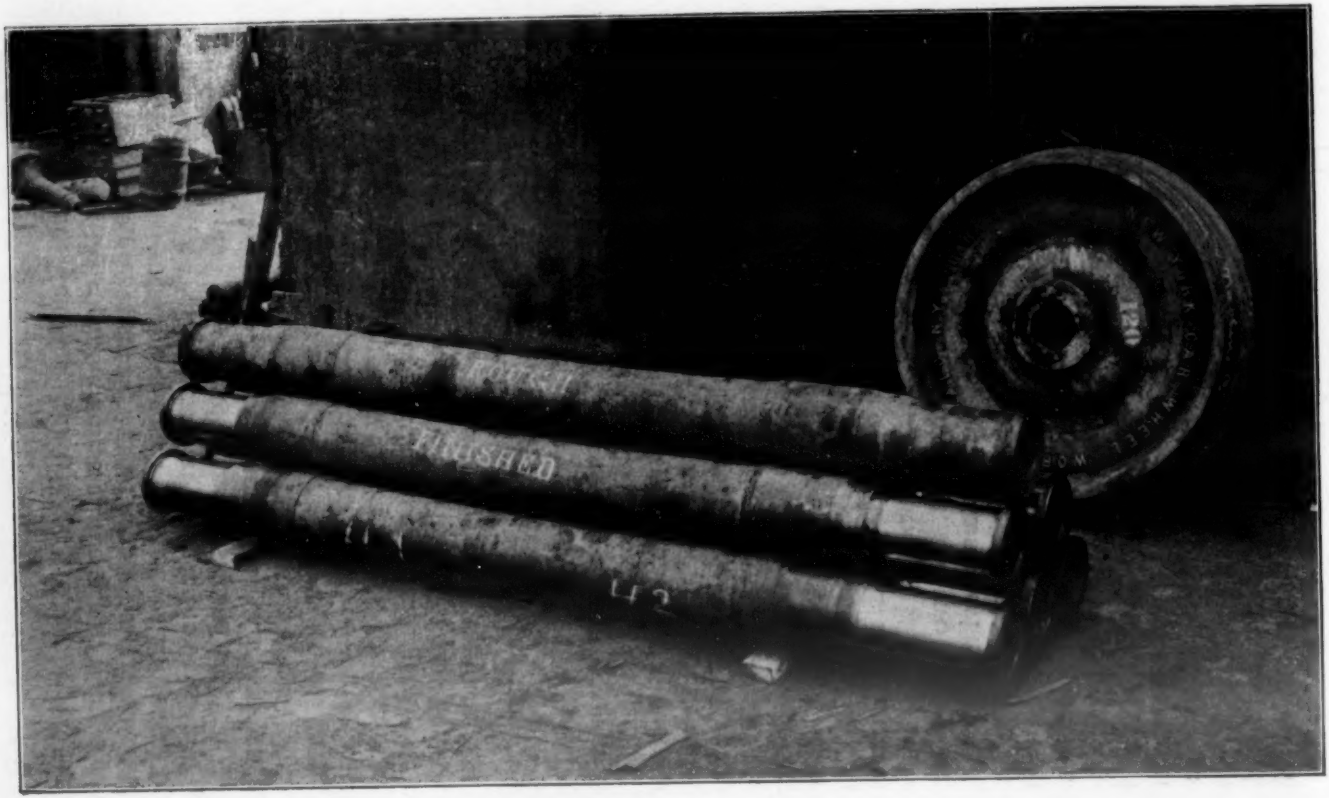


PLATE VI

sents over 20% of the theoretical strength of a $5\frac{1}{2}'' \times 10''$ journal. A smaller punch would not stand the strain, which again means that this process could not be adapted to any axle except the one just mentioned, which is that used on the 55-ton freight cars. It was also a question whether the parts joining the solid center and hollow ends were considered safe.

A number of the difficulties enumerated were overcome, some wholly and some in parts and again, others not at all. The result was the recent abandoning of the process, it having been found according to my informant that about 20% of the product had to be scrapped as unreliable. It remains, however, as an exceedingly interesting mechanical experiment in general, reflecting considerable credit upon the inventor, the late Mr. Mercader, and as the greatest effort up to that time to improve and cheapen the manufacture of axles.

The next step in the evolution of axle manufacture is one invented by myself. A number of years ago, while connected with the Pencoyd Iron Works, I designed an upsetting machine for bridge eye-bars, adopting in this connection a system of dies, which, generally speaking, may be considered to consist of a closed box, enveloping a stationary bar and arranged to move longitudinally against its free end. This machine, as well as a larger one—built later on the same lines—have been both successfully operated for years by the American Bridge Company, and as a result of my work in this direction, came the suggestion of embodying the upsetting principle to a billet with the view of producing an axle. Plates VIII, IX, X and XI show the machine intended for this purpose. It consists of a central stationary die, horizontally split, and two moving end dies similarly divided, each of which contains a cylindrical heading die, the latter possessing a slight longitudinal movement inside of its respective end die. The upper halves of the split dies are simultaneously lifted or lowered by being all suspended from an upper casting containing two hydraulic cylinders, the pistons of which are stationary and butting against a long top frame, which in turn at its ends is tied to the lower bed-plate by four heavy bolts. This lower bed forms the housing for the die-system. On each side or end of the housing are two horizontal, telescopic cylinders, the tiebolts of which are in part attached to the bed-plate. The main piston in each

PLATE VII

outside cylinder is attached to and operates each moving end die. It is, however, a cylinder in itself, the piston of which butts against the cylindrical heading die, above mentioned.

The dies being lifted, a billet cut to right length and weight is pushed into the machine sideways between the vertical bolts by a small manipulator, the dies closed and the main end cylinders opened to the water. This operation carries all the moving dies, including the header, towards the stationary center, the heading dies at present remaining inoperative with relation to the moving end dies. The entire system is stopped at the end of the stroke by an abutment on the stationary center die, allowing $\frac{1}{4}''$ as the thickness for the collar of the surplus metal at its narrow edge. Some distance before the stroke is finished this collar commences to form, as the sliding friction between metal and inside of dies, especially during the period of forming sharp corners, is so great that the material will rather flow sideways into the open space. A collar formed under such conditions would quickly stop the up-setting stroke and in order to overcome this difficulty, the adjoining ends of center and moving dies are provided with shears that undercut the collar, enabling the upsetting stroke to complete the work. The water is now permitted to enter the inside cylinders, whereby the outer axle collars are formed, allowing a place as shown for the surplus fin of material. The two inner or central pins must be cut off before the axle can be removed, as otherwise the product is locked in the dies. This is accomplished by the inside cylinders, automatically and simultaneously with the forming of the outer collars in the following manner:—Each half shearing-die has two bolts screwed into its front collar and is moved forward by the stroke of the inner ram, as shown in the plan view.

The stationary center shear is simultaneously yielding longitudinally by having its ears or side wings forced backwards by movable upper parts of the lower side guides, which again are operated by the inner rams through the main pull-back cross-head, as shown in plan view. The retirement of the center die sleeve, as just described, is made possible by the previous withdrawal of the middle wedge-shaped part.

The process of operation of the valve levers will hence be as follows:—

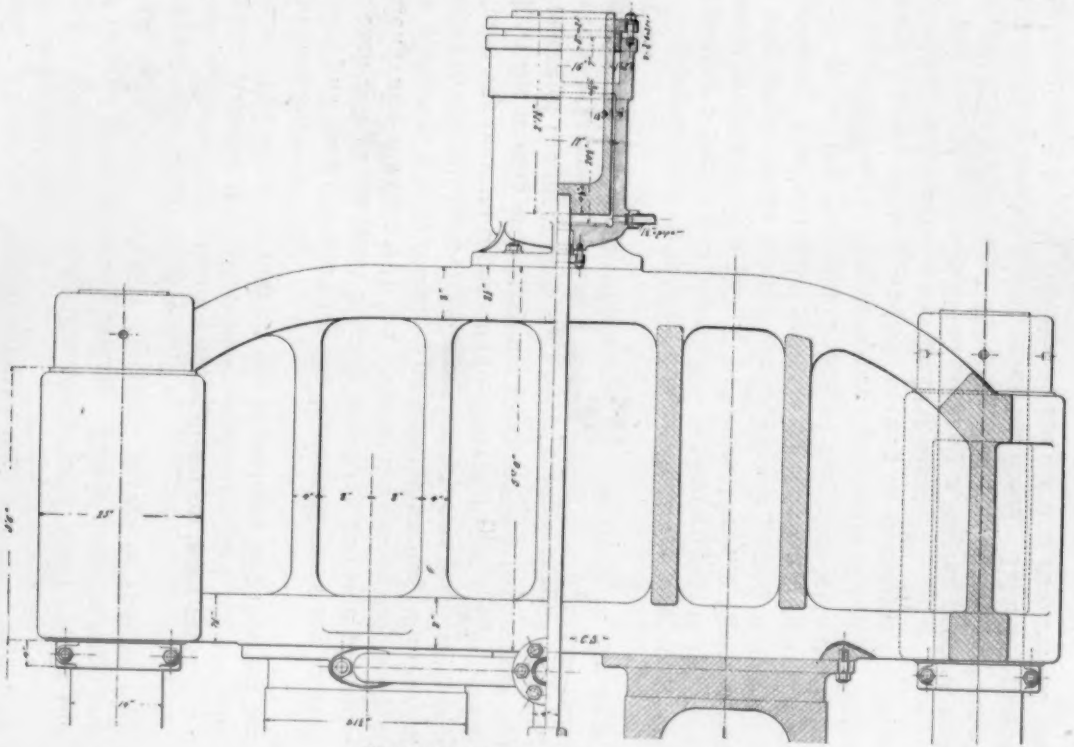


PLATE IX. Upper part of front elevation

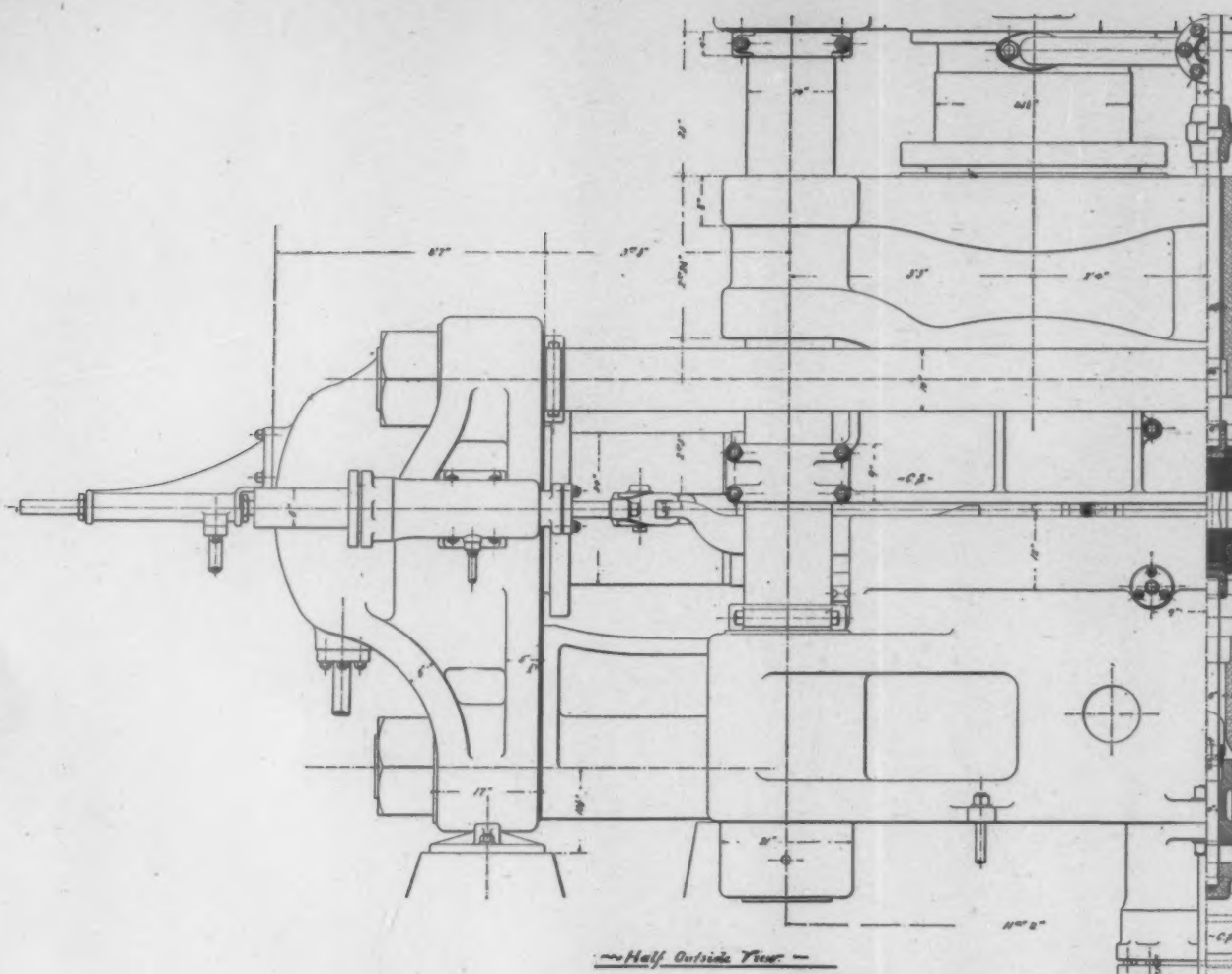
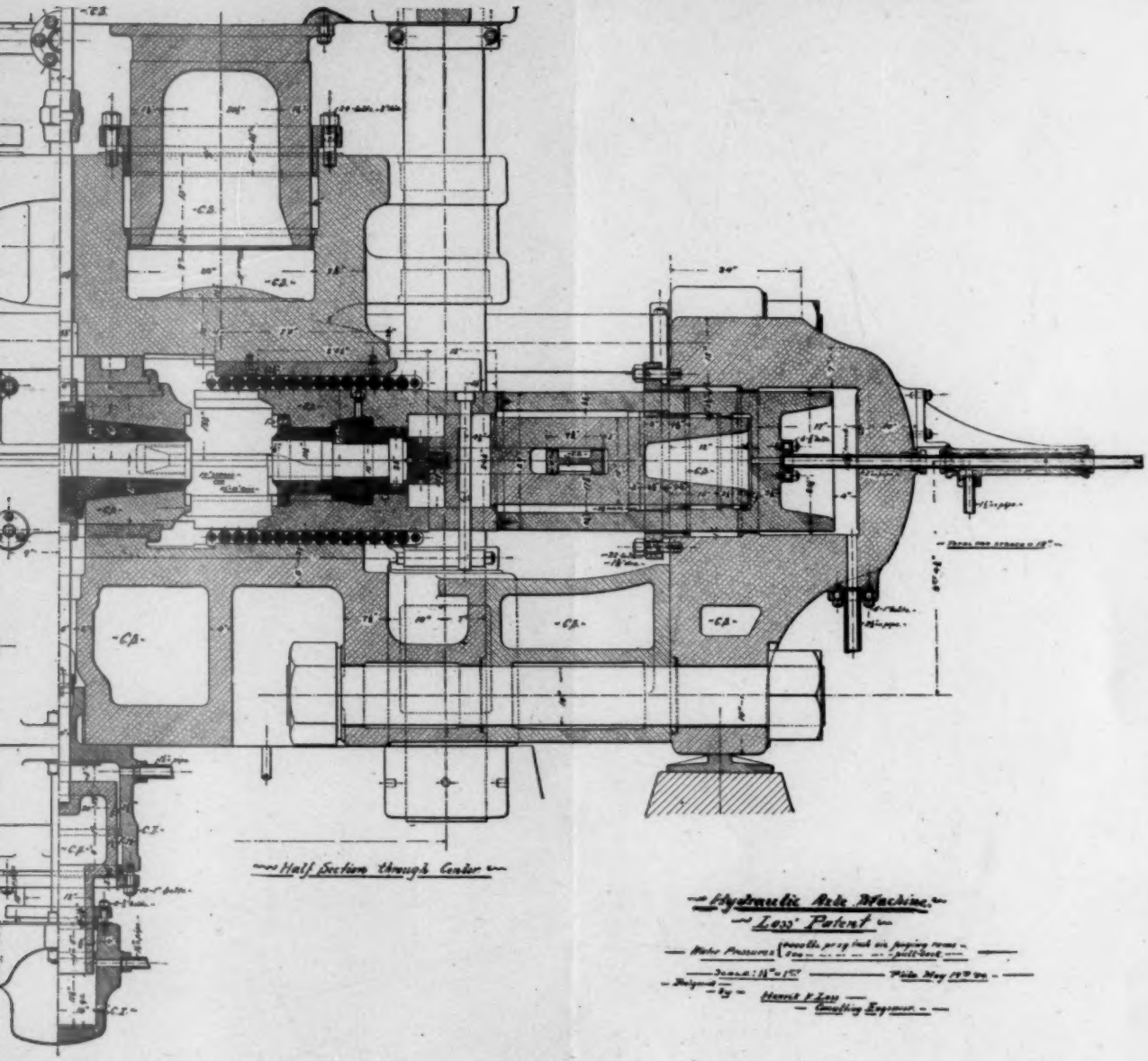


PLATE VIII. Lower part o



Lower part of front elevation

1st. Close dies vertically by letting low pressure water on main rams, afterwards locking same or applying an intensifier.

2nd. Throw low and afterwards high pressure water on main horizontal rams.

3rd. When the moving dies stop, throw water on the top and bottom low pressure cylinders. This is done through one single valve lever. Also, if necessary, unlock or remove high pressure water from die closer.

4th. Throw high pressure water direct on inner rams.

5th. Reverse levers for horizontal rams and for the die-closer. The water on ram on top of machine will then lift the die-closer automatically.

The pull-back cylinders for the horizontal rams are located on each side of the main cylinder and have constant pressure, which is also the case with the lower of the two cylinders under the bottom of the machine. The pins connecting the moving guides to the pull-back cross-heads are made as breaking pieces in case any unusual cause should prevent the movable die lining in the middle stationary die from moving back under the pressure of the inner ram. As another precaution a breaking piece is attached to the end of this inner ram where it bears against the four bolts which operate the shear in the moving die

The capacity of the holding-down cylinders is 3500 tons, representing a pressure of 10,000 lbs. per square inch of the horizontal projection of a $5\frac{1}{2}'' \times 10''$ journal axle, a figure which is very ample in the light of the experience gained in upsetting eye-bars. The horizontal pressure is 1000 tons at each end, or over 50,000 lbs. per square inch of the cross-section of the largest axle used. This excessive figure will, of course, insure sharp corners on the product, as well as overcome the large fractional resistances inside the long dies.

The upsetting of a steel bar is simply a forging process, conducted in a longitudinal direction, and if properly performed, will similarly condense and refine the metal. Like any closed-die method, it is very superior to the use of a hammer for reasons as previously given.

In all longitudinal forging there is a tendency to buckle or bend and if the piece under treatment is not properly guided, excessive buckling will result in laps or laminæ that render the

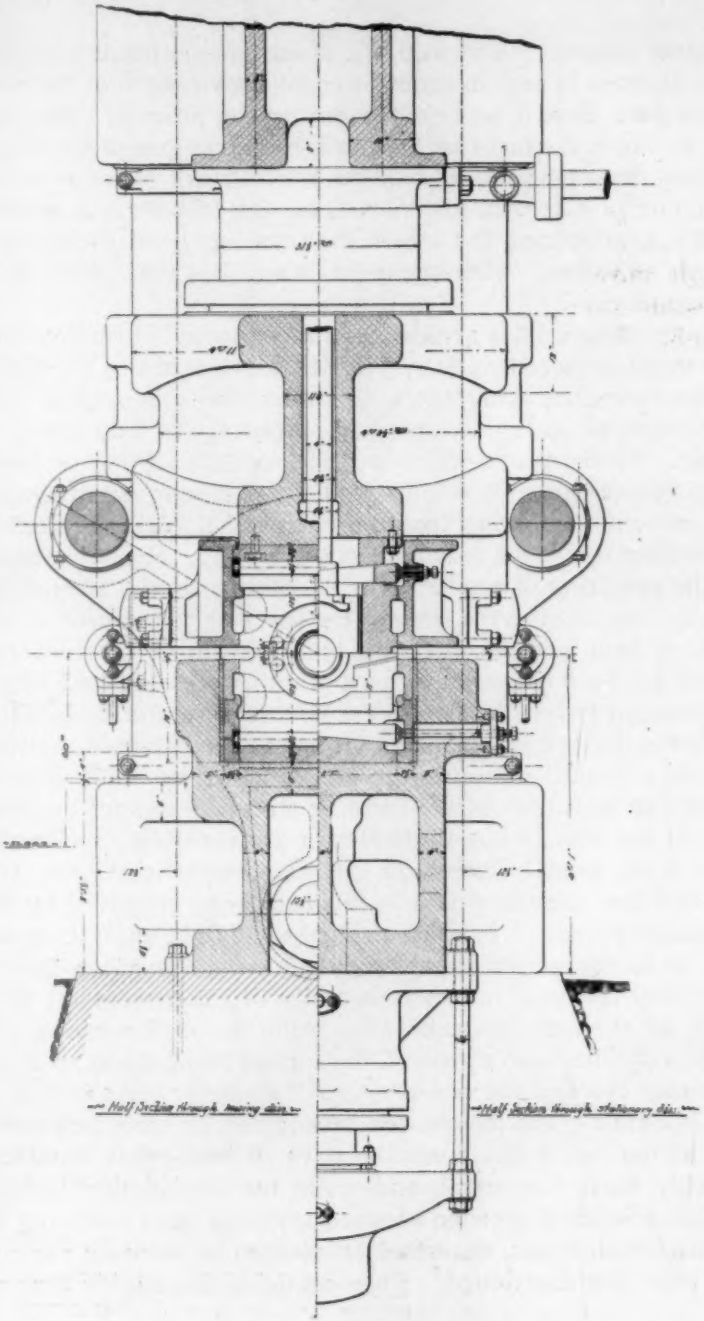


PLATE X End views

product useless. With iron, the upset portion needs considerable increase in area in order to equal the strength of the non-upset part, even if well guided during the process. The reason is simply the fact that as iron is not homogeneous, a longitudinal pressure with subsequent yielding will cause an intermingling of the so-called "fibres" or slag laminæ in a manner partly approaching the condition resulting from upsetting a bunch of wires. Homogeneous steel, however, acts quite differently.

With surface folds avoided, it matter not in which direction the metal is forced to flow. Eye-bars are upset to an extent of the new area being 150% in excess over the original one, while with an axle this increased percentage is only about 50 or 60. Hence if eye-bars are made without folding or buckling, no question of that kind can legitimately be raised against the axle, remembering that the billet is held or supported at its middle, where the moving dies will first fill. Referring again to the upsetting of eye-bars, the excess of material around the pin, as compared to the body of the bar, was 50 per cent. in the days of iron bridges, but with the substitution of steel, this figure has been cut down to from 20 to 25 per cent. and I have witnessed eye-bars with 6% excess break in the body when placed in the testing-machine. It must be understood that this excess of metal, whatever the percentage may be, is also intended to take care of the bending stresses existing on each side of the pin, and as these strains are naturally much more than 6 per cent. in excess of the plain bar tension, the test showed that the metal had in this case been improved by the upsetting process. In order to shed some light upon the problem as to the condition of upset steel, the American Bridge Company last year instituted a series of experiments at Pencoyd, all of which, however, were made on small sections, viz: $6'' \times 1\frac{5}{16}''$ bar and $2''$ round, the former being upset to a $14''$ diameter eye and the latter to a $2\frac{1}{2}''$ diameter for a length of $5\frac{1}{2}''$. I have heard the opinion entertained by some engineers, —inherited no doubt from the days of iron—that upsetting actually hurts the metal, and while the explanation already given as to the difference between iron and steel could not be contradicted, I was, nevertheless, pleased to secure a copy of the tests just mentioned. They establish thoroughly that no

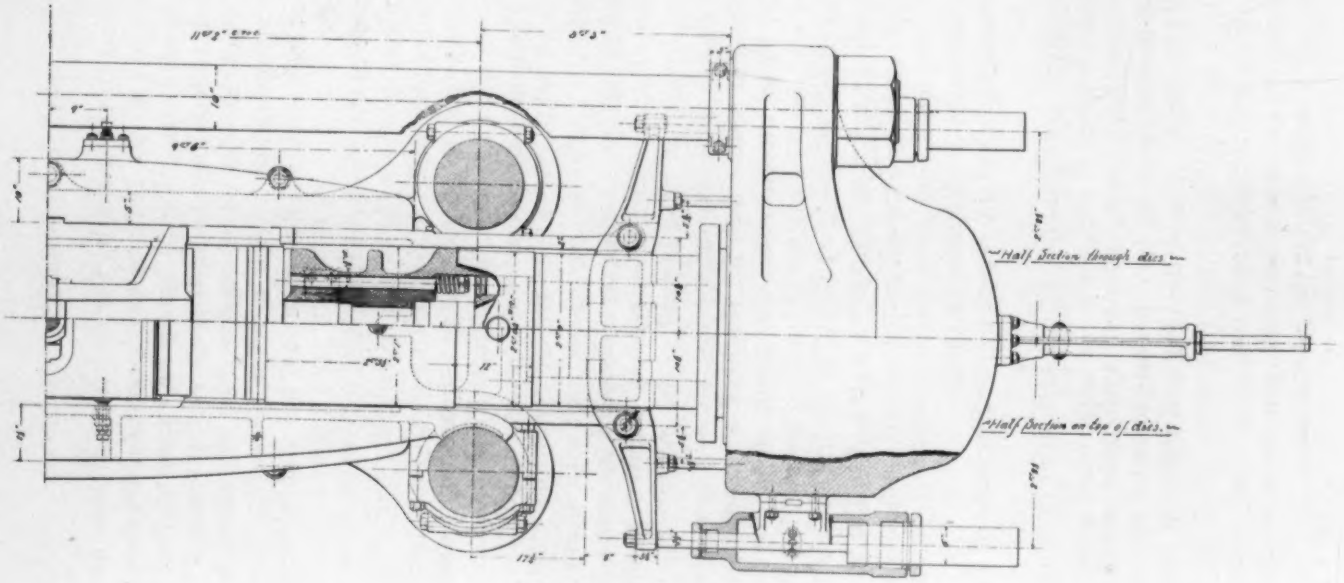


PLATE XI. Plan view

harm is done to the metal by the upsetting process and while the upset parts do not indicate any special superiority, it must be remembered that it could hardly be expected that a large ingot when rolled down to such small sections as a 2″ round, or 1 $\frac{5}{16}$″ thick bar should be improved by any subsequent mechanical manipulation. With a billet, however, the result would not only show no deterioration, but a decided improvement.

A resumé of the Pencoyd tests is as follows:—

Four pieces of the body of the rectangular bar when *turned* and threaded and pulled in the testing-machine showed elastic limits from 37,600 to 40,700 lbs. per square inch, with practically no variation between the annealed and unannealed portions. Their ultimates were from 67,700 to 67,900 lbs.

The upset head gave under similar conditions elastic limits from 37,800 to 42,250 lbs. per square inch with ultimates from 69,100 to 73,300 lbs. Other test-pieces of the same bar similarly taken, but of *square* cross-section, showed a slight decrease in strength of head instead of the increase above given for the round sections, registering an average ultimate of 69,000 lbs. per square inch for the head as against 71,000 for the bar. Here, therefore, the one result offsets the other and is, I dare say, merely a matter of speed of testing, heating, etc.

On the round 2″ bar upset to 2½″ at its end the elastic limits of the body varied from 33,000 to 39,000 lbs., the steel being softer in this case and the ultimates ranged from 57,640 to 61,350 lb. The upset ends gave elastic limits from 30,000 to 38,700 and ultimates of 56,200 to 61,100 lbs.

The summing up of the report by the Engineer of Tests is as follows:—

"Differences between body of bar and upset portions do not seem to be marked in any case."

The "Stahl und Eisen," of April 15th, 1905, contains a detailed statement covering two separate months' operation of a German axle plant. I have thought it of sufficient interest and importance to have this article translated, adopting also our money terms and weights, each ton being 2,000 pounds. The plant contained two steam hammers, one large for the body of the axle and a small one for the journal part.

FIRST MONTH.

Open Hearth Billets used as follows:—

34.65	Tons	at	$17.92	equals $ 620.95	
210.206	"	at	16.84	equals 3540.00	Cost per ton of finished axles.
33.86	"	at	14.46	equals 489.60	
Total 278.716	" at avg.		16.68	" 4650.55	$21.10

Coal for heating blooms : 53.5 tons at $2.40	128.25	0.58
Coal for steam boilers : 68.00 " at 2.40	163.20	0.74
Wages paid for the month	317.00	1.44
Incidental expenses	71.40	0.32
Insurance per month	12.13	0.06
Depreciation of boilers	17.70	0.08
Total	$5360.23	24.32
Saleable scrap such as crop ends and chips (15%) : 41.97 tons at $11.84	497.18	2.25
Net output of rough turned axles 220.40 tons	$4863.95	22.07

NOTE:—

After hammering, but before being cropped and turned, the output weighs 262.27 tons, which means a loss in weight by scaling in furnace and at hammers of 16.44 tons or 6%.

The finished axles equal 79% of billets. Axles sell in Germany for $34.60 per net ton.

The output is worth $7625.84. Net profit per month equals $2763.82 or $12.54 per ton.

At four axles per ton average, the above output equals 882 axles or 37 axles per day.

SECOND MONTH.

		Cost per ton of finished axles.
166.16 tons of Basic O. H. Billets used at $16.84 per ton	$2793.13	$20.40
Coal for Steam Boilers 44.09 tons at $2.74	120.45	0.88
Coal for heating furnace 41.76 tons at $2.74	114.03	0.83
Wages paid for the month	232.12	1.69
Castings for repairing	22.85	0.17
Other materials used	191.75	1.40
General expense	74.76	0.54
Insurance	9.19	0.07
Depreciation of boilers	10.55	0.07
Total	$3573.83	26.05

Saleable scrap such as crop ends and chips (14.7%) 24.57 tons at $11.20	290.00	2.11
Net output of rough-turned axles 137.17 tons	$3283.83	$23.94

NOTE:—

After hammering, but before being cropped and turned the output weighs 161.74 tons, which means a loss in weight by scaling in the furnace and at the hammers equal to 4.42 tons or 2.60%.

The finished axles equal 82.5% of billets.

At 4 axles per ton average, the above output equals 550 axles or 23 axles per day.

Selling price equals $34.60 per net ton.

The output is worth $4746.00.

Net profit for the month equals $1463.00

" " per ton equals 10.60

CHEMICAL ANALYSIS OF AXLES.

Silicon	Phosphorus	Manganese	Carbon
1.07	0.08	0.78	0.17
1.03	0.092	1.38	0.18

Tensile strength	Elongation	Contraction
71262 lbs. per sq. in.	18%	28.1%
77236 " " " "	19%	36.0%

It is seen from the above that the saleable scrap, such as crop ends and chips, amounted to 15% in one month and 14.7% in another.

The article does not clearly state whether the product was rough-turned or finished, ready for the wheels. Unless an axle is shipped as a unit with its two wheels, it is nearly always rough-turned, the finishing being done at the place of assembling. In any event, the finishing cuts represent but a small, fractional part of the total scrap and might be ignored in a comparative estimate.

There is also to be observed the extreme softness of the material. Steel with .17 or .18 carbon has long ago been given up in this country for axle purposes.

In order to throw light upon the saving effected by the introduction of die-forged axles I collected some data covering output and costs in one of the larger axle hammer plants in the Pittsburg district. With die-forged product, I have been guided as to necessary labor and output by the results of the

two eye-bar upsetting plants now in existence. One boy is intended to work the press valves and another to operate the valves for the manipulator, which latter picks the billet up from a roller bed and carries it sideways between the uprights into the machine, where it is finally deposited in the dies. After the forging is completed, a similar manipulator on the other side of the press removes the forged axle. One man will look after the process generally and grease the dies. It is believed that these three workmen will suffice for the operation of the machine proper, with an output that is only limited by the ability to cool the dies, which will be done by sprays of water.

COMPARISON IN COST OF THE MANUFACTURE OF RAILWAY CAR AXLES BY HAMMER AND BY PRESS.

Forging by Hammer:		
One Hammer—3 men and 1 boy—$1.75 per hour		
Average 5 axles per hour; wages for hammering.....	35c.	per axle
One Press—One man and 2 boys—90c. per hour.		
Average 20 axles per hour; wages for pressing.....	4½c.	"
Saving in wages per axle.....	.30	
" " cutting ends and centering.....	.15	
" " turning per axle.....	.15	
" " straightening	.05	
Total per axle.....	.65	
Averaging 3 axles per ton, which covers the present heavy freight cars, this saving becomes.....	1.95	per ton
Saving in repairs to hammers and to other machinery.....	.15	" "
Saving in fuel, based upon 50 horse-power, as the average work of the hammer	.15	" "
Total per ton.....	2.25	
Scrap:		
Minimum amount saved per axle, 70 lbs. or about 200 lbs. per ton = 10%. (German test during two months' run gave 15%).		
Difference between prices of axles and scrap 1¼c. per lb...		
Saving through scrap	2.50	per ton
Total saving per ton.....	$4.75	

Including everything, it should be perfectly safe to count a saving of $5.00 per ton over the best modern practice, a figure

which with a low-priced product, as this is, would warrant the scrapping of any present plant in existence.

Taking the process as a whole, a summing up of its facts and merits may be stated as follows:—

1st. Work on the metal—When forging an axle by hammer, the outside fibres or parts receive more work than the centers or inner ones. When upsetting it, however, the inner parts are shortened just as much as the outer ones and hence the flow at the center is just about as great as at the surface.

2nd. Work on the metal—In the ordinary method of forging an axle under the hammer, the main work is done on the middle part and a minimum at and near the wheel-seats. With the upsetting process these conditions are reversed,—the wheel fit and adjoining parts receiving the greatest amount of forging as they properly should do, these regions being the most liable ones to breakage.

3rd. Repair account—This item becomes very excessive with hammers, while with a well-designed press it is practically nothing barring wear of die-sleeves.

4th. Labor—Four hammers require twelve men and four boys, while one press being the equivalent can be run by one man and two pulpit boys.

5th. Fuel—Instead of the wasteful process of a steam hammer, the single stroke hydraulic process, when operated on the intensifier principle, means a considerable saving at the boilers.

6th. Turning—The axle when made is true and smooth throughout. Less allowance needs hence be made for turning of wheel fit and journal and then again between the wheel fits; the surface being true and smooth, the material is better off by having the hard outer scale remain intact. Hence no rough-turning.

7th. Straightening—The entire die system for both ends are planed units, well guided in housings, that take in the entire length of the axle, and hence the product must be straight when removed from the dies. If the axles are run directly from the upsetting machine down an inclined track through a continuous furnace, a hot axle entering at one end while a cold or cool one is leaving the other, there would be no danger of the axle again curving and the straightening process can be eliminated.

8th. Centering—The centering and cutting-off operations are omitted, as the axle can be upset to length and the heading die fitted with a tit which will center the axle while upsetting it.

9th. Cost of installation—An upsetting machine with all intensifiers and a complete valve system will cost about $30,000. Add $10,000 for piping, foundations and dies, the total becomes about $40,000, if low pressure water is available. The latest hammers at one of the leading axle works cost about $8,000 apiece. For the same amount of production we shall need about four hammers, which, with their expensive foundations, would involve a cost of at least $40,000, assuming steam to be had, this figure equalling the expense of one complete press. Likewise is saved cost of axle lathes and of the centering and cutting-off machinery.

10th. Capacity—The actual time to make an axle will be from 3 to 5 seconds, but the real time will, of course, include the removal of axle and the insertion of blank. With proper arrangements for removing the finished article from one side of the press and for the feeding of the blank on the other, two minutes would be ample for the process. Certainly one machine will be able to make twenty axles an hour, allowing a safe average and also considering time necessary for cooling the dies.

11th. Scrap—From sixty to ninety pounds of scrap is saved per axle. This figure includes the material removed by rough-turning and by cutting off the ends. At times this figure reaches 100 to 110 lbs.

12th. The blank or billet can be octagonal if desired; it needs not be round. It is not smooth rolled, but it is essentially a *billet* and not a *rolled bar*.

I have had made a model in hard wood at $\frac{1}{8}$ scale, which is shown here to-night. A number of axles have been upset on it, the material operated upon being that used in the manufacture of picture frame mouldings and consists mainly of linseed oil, white lead, glue and some sugar or molasses, this mixture being also accepted by the United States Patent Office as a guide to its decisions regarding flow of metal. Some of the product of the model is also here to-night for your inspection

and shows clearly the flow of the material with its different fins and offsets.

Mr. Chairman and members of the Institute, I thank you very much for the interest shown and the attention given me this evening.

STRENGTH OF GRIND-STONES—WET AND DRY.

Tests seem to indicate that the strength of a grind-stone is considerably reduced when it is wet. The wetting not only decreases the tensile strength of the material, but it adds weight and thus augments the centrifugal pull at a given peripheral speed. The reduction of strength appears to be as much as 40 or 50 per cent. A dry section of stone broke under a stress of 146 lbs. per square inch. Another section of the same stone, soaked over night in water, broke at 80 lbs. A better stone, under the same conditions, broke under stresses of 186 lbs. per square inch when dry and 116 lbs. when wet. Much difference of opinion prevails as to the maximum safe allowable speed at which to operate the stones. Some grinders use a peripheral speed as high as 4500 feet per minute, while others limit it to 2500 feet. Little difference is observed in the liability to breakage, this leading to the conclusion that a frequent cause of breakage must be hidden in flaws or cracks, which would permit the disruption of the stones at the lower speeds.—*Iron Age.*

PRODUCTION OF IRON ORE IN 1905.

The production of iron ores in 1905 in the United States amounted to 42,526,133 long tons, as compared with 27,644,330 long tons in 1904, with 35,019,308 long tons in 1903, and with 35,554,135 long tons in 1902, a gain in 1905 over 1904 of 14,881,803 long tons, or about 54 per cent. The value at the mines of the ore mined in 1905 was $75,165,604, a gain as compared with the 1904 value, $43,186,741, of $31,978,863, or 74 per cent. As in the six preceeding years, the production of iron ores in the United States in 1905 was never equalled by that of any other country.

PRODUCTION OF COPPER IN 1905.

The production of copper increased from 812,537,267 pounds, valued at $105,629,845 in 1904, to 901,907,843 pounds, valued at $139,705,716 in 1905, an increase of 89,370, 576 pounds in quantity and of $34,165,871 in value.

ELECTRICAL SECTION.

(Stated Meeting, held Thursday, November 22d, 1906,)

Independent Telephone Development.

By James B. Hoge,

President of the International Independent Telephone Association of America, Cleveland, Ohio.

Considered from the standpoint of practical utility and convenience, the telephone is the greatest invention of this progressive and inventive age. It may be justly claimed that its adoption marks an epoch in human progress, since its use has done more for all practical purposes to annihilate time and distance than any other method of communication or transportation. Few perhaps think of the telephone in connection with transportation, yet to-day it is doing very much to make travel in many instances unnecessary. Stop a moment and consider how much more crowded the streets of your city would be if it was not for the use of the telephone. "Don't travel—telephone," is a sound maxim that is being very generally observed.

I ask your pardon for digressing a few moments to call attention to what seems to be an inherent human instinct, the desire for rapid means of communication. We see it manifested even among savage peoples, and explorers tell us of a unique plan in use by the tribes of certain hill countries. A messenger is dispatched to the top of the nearest hill and shouts his message, using a code of whoops and yells, to the next messenger, who transmits it in like manner from the next hill top, and so on. By this means, we are told, the tribes could communicate very rapidly with each other. The American Indians at the time this country was discovered had a well developed

system of smoke signals, which enabled them to transmit intelligence regarding the movements of their enemies or any important matter in a very brief space of time. Numerous methods were employed by the early settlers for communication between centers of population; we find the slow going messenger wending his way over hill and dale, the lumbering stage coach, making its way over the old National pike, and other post roads, with a few passengers and heavy mail pouches, with relays of horses and drivers, covering at best from forty to sixty miles a day; the more rapid pony rider mail carrier, often averaging 100 miles a day. Then there was the wigwag system, seldom, if ever, used in civil life, but employed in military circles. Then the steam railway, a wonderful improvement over the stage coach, reaching at first, in a limited way, the principal centers of population over circuitous routes, with heavy grades and crude construction, but passing from improvement to improvement and developing into the wonderful railway system of to-day that makes possible our Twentieth Century Limiteds, traveling palaces, rushing across the country with their precious human freight, conveying the United States mail from this city to Chicago, a distance of 825 miles, in 16 hours.

Now, as a crowning achievement in methods of communication, we have the telephone, which, like all other electrical inventions, was made possible by the one whom you have seen fit to honor by naming your institute after, who with his kite discovered that wonderful, mysterious fluid we call electricity, leaving its great power, its varied applications, as a problem for future generations to utilize for their profit and pleasure. Truly the citizens of the civilized world owe to Benjamin Franklin a debt of gratitude which will carry his name down to future ages as a benefactor of mankind. Far seeing as he was, he could scarcely have imagined the extensive use of his discovery, the wonderful inventions and progress in which it would result, and could he revisit this city to-night, he would not believe that it was his discovery that made possible the beautiful lights upon your streets and in this auditorium, the power that moves your street cars, that operates your telegraph instruments, and that beneath your streets are thousands of miles of copper wire, over which conversations are be-

ing carried on between parties located many miles apart, as clearly and distinctly as though the speakers were in the same room. This indeed is a wonderful age and the telephone is not the least of its wonders.

To return to our subject, the first public record of a device for the transmission of speech over an electric conductor appeared on August 18th, 1854, in a magazine published in Paris, known as the "Illustrated Universal Journal," giving an account of a crude apparatus constructed by Charles Boursel, a soldier in the African army, who had attracted attention by delivering a course of mathematical lectures to his comrades in a garrison in Algiers in 1848. Boursel, in describing and explaining his apparatus, made the startling announcement that "The spoken word in Vienna could be instantly transmitted by electricity to Paris." Nothing is on record to show that Boursel made any practical use of his invention, but in 1861, Philip Reis, a teacher in a boys' school in Fredericksdorf, near Hamburg, Germany, came before the public with an apparatus with which he claimed he was "enabled to reproduce the tones of various instruments and even to a certain extent of the human voice." Reis called his invention the telephone, the name by which it has since been known. He also manufactured and sold the apparatus in a limited way. As early as 1860, Daniel Drawbaugh, of Eberly's Mills, Pa., a little town of half a thousand inhabitants, about ten miles southwest of Harrisburg, in the Cumberland Valley, was endeavoring by experiments with the primitive appliances within his reach, to convey vocal sounds over an electric wire. There is nothing to indicate that he ever heard of Boursel or Reis, but between 1867 and 1869 he succeeded in constructing an apparatus consisting mainly of a glass tumbler, a tin cup and a mustard can, connected through a membrane, by means of a wire leading from a battery, with another instrument placed some distance away, over which he was able to transmit vocal sounds of a certain range. The device was crude, and Drawbaugh was not sufficiently skilled to comprehend or explain the scientific principles involved.

On February 14th, 1876, two petitions were filed in the United States Patent Office, making application for a patent on the telephone, each describing it as an invention for "trans-

mitting vocal sounds telegraphically." One was a formal application by Alexander Graham Bell, of Massachusetts, the other a caveat on the part of Elisha Gray, of Illinois. It was a coincidence without parallel in the history of the Patent Office, as both covered practically the same ground, and involved the same points. However, the patent was granted to Bell, on March 7th, less than a month after the application had been made. One of the first instruments manufactured was exhibited at the Philadelphia Centennial that year.

Immediately after the patent had been granted, the Bell Telephone Company was organized under the laws of the State of Massachusetts. Later the Western Union Telegraph Company secured control of Gray's device, with improvements thereon by Edison, and started in the business of installing and operating telephone exchanges in direct competition with the Bell Telephone Company. The latter realizing that their anticipated monopoly was in serious danger lost no time in ridding themselves of competition. A deal was promptly made with the Western Union, then suits were brought against all of the Bell's other competitors to enjoin them permanently from using telephone apparatus. This case reached the United States Supreme Court in 1888, and was heard before seven Judges, four favoring the Bell Company and three dissenting. The dissenting members of the Court based their opinion on their belief in the priority of the invention of Daniel Drawbaugh of this State.

The Bell Company, being put in possession of the controlling patents by the United States Supreme Court, and having made their arrangements with the Western Union to keep out of the field, apparently felt there was nothing further to fear from competition. Accordingly they continued the business policy which they had inaugurated, charging exorbitant rates and restricting the service, preferring to do a small business at high prices to popularizing the service at reasonable rates. The treatment of patrons, as might be expected from a gigantic corporation having such a complete monopoly, was arbitrary in the extreme.

The telephone business of the country continued with this policy of management until the patents expired in 1894. In December of that year, there were 291,253 complete tele-

phones installed in the United States, or approximately one for every 240 persons. By this time, the public had become so thoroughly aroused over the fact that they were prohibited from enjoying what seemed to them a wonderful convenience, if not an absolute necessity, that people from all walks of life in every community were ready to go into the business, not so much with a view of financial gain as for the purpose of securing the telephone service they needed. The Bell management felt certain that the invention of Emile Berliner, whose patents they had purchased and which were filed in the Patent Office June 4, 1877, but not issued until November 17th, 1891, would prolong the monopoly of the business until at least 1908; so when competition was threatened, every officer of an Independent company, as well as every subscriber to an Independent telephone, received a notice from the Bell Telephone Company that they were infringing patent No. 463,569 of Emile Berliner, which the Bell owned, and that they would be held responsible for infringement and damages. Nor was this an idle threat; in nearly every instance previous to 1888, upon the rendering of decisions favorable to the Bell, Independent companies were driven out of business and their equipment reduced to scrap and burnt, widespread publicity being given to such cases as a warning to other foolhardy investors, who might dare to invade the field of the Bell monopoly. It required courage in those days to engage in the Independent telephone business, when the investors faced the prospect of being prosecuted for infringement, and having their property confiscated and destroyed. Yet courage and faith were not lacking among the pioneers of the industry, and the present extensive system is a monument to their daring and perseverance.

Feeling the hopelessness of fighting the Bell single-handed, some of the prominent men in the Independent movement invited representatives of all the known companies in the United States to come together in Detroit, Michigan, on June 22nd, 1897, for the purpose of forming an organization for mutual protection. This organization was effected, and a substantial sum subscribed to defray the expenses of fighting the patent cases through the Supreme Court of the United States, if

necessary. One after another these cases were carried through and won by the Independent interests.

Telephone apparatus at the time the patents expired in 1894 was very crude, the service was slow and transmission unsatisfactory. To supply the widespread demand for apparatus, Independent manufacturing companies started up almost immediately, improvements were made on the apparatus, competition between the different interests put all on their mettle, and more was accomplished between 1896 and 1900 in the way of improving the apparatus and service, and extending the use of the telephone, than had been done in twenty years previous. Prior to 1896, a telephone in the country was a decided novelty; to-day it is so common as to attract no special attention. After establishing themselves in the smaller cities, the Independents extended their lines out into the country, reaching all the post offices in a county; then the farmers began to organize companies and build, bringing their lines into the different post office centers where exchanges were installed, each county becoming a net work of wires. This service has been constantly increasing, finances for its development being in most cases furnished locally, until to-day there is over three hundred million dollars invested in Independent telephone properties, with more than three and a half million telephones installed and several hundred thousand miles of long distance toll lines connecting the different exchanges. The people in many of the larger cities, where the Bell was furnishing telephone service, were slow to appreciate the advantages to be derived from competition. They realized very often that they were paying more than their service was worth, and that there was a great deal of room for improvement in both the service and treatment, but dreaded to burden themselves with two telephones, "the double telephone nuisance" as the Bell taught them to consider it. In many cases where the citizens were willing, in fact anxious to have an Independent exchange installed, they were prevented through the Bell's control of their chosen representatives, who sometimes placed their own pecuniary gain above the welfare of the people they were elected to serve. If this entire history was written up by Miss Tarbell or some of the other well known writers, who have made a specialty of corporate methods, it would prove

equally interesting and enlightening as the record of the Standard Oil Company or any of the other great trusts. One by one, however, the Independents have won their fights for entrance into the larger cities, the common sense of the citizens, when the real facts regarding telephone competition had been made clear to them, demanding Independent companies as the only means of securing justice in telephone rates and service.

Sometimes the Independent companies, in the early days, after obtaining franchises were unable to develop their property in the face of the greatly reduced rates, or even absolutely free service promptly offered by the Bell Company, and were forced to retire or sell out to the monopoly. Wherever this has happened, with scarcely an exception, another Independent Company has been formed, proper provisions being made to prevent a like occurrence. One or two examples may not be amiss. A few years ago an Independent plant was installed at Portland, Oregon, and forced the Bell to reduce its rates and improve service; it was not strong enough, however, to withstand the continued attacks of the Bell Company, backed by other corporations and political power in control, and finally sold out; rates were at once raised and service became unsatisfactory from an operating standpoint. On December 7th, 1904, an application for another Independent franchise was presented, and after a fight which brought the matter into politics, upon the petition of 10,000 voters the matter was submitted to a vote of the people the following June. The result was 12,213 votes for and 560 against the franchise. Evidently the citizens of Portland prefer competition to monopoly after having tried both. At South Bend, Indiana, the first Independent Company was forced to abandon the field, but its successor to-day has over 3,000 telephones in South Bend against about 900 of the Bell, although the rates of the latter are the lower at present. In the entire county the Independents have 5,000; the Bell about 1,000. Perhaps the South Bend people do not forget that it was not until competition was introduced that rates were lowered, and that when the first Independent Company had been removed from the field rates were promptly raised. No doubt they also appreciate that the present extensive development is due to competition, for under

monopoly the Bell had only 240 subscribers, and showed no disposition to extend its service.

On November 6th, the citizens of Omaha, Nebraska, at the regular election ratified an Independent franchise by a vote of 7,653 to 3,625. The Independent victory there marks the close of as fierce a fight as the Bell has ever made in any city of the country against the entrance of competition. For over three years this struggle has been going on, the Bell using every influence and sparing no expense in its efforts to retain its monopoly. There is a reason for its activity, for with Omaha added to the Independent list, the Bell's one claim to the toll service of the country surrounding it has disappeared, since in all of the territory tributary to Omaha the Independents outnumber the Bell. In Nebraska the Independents have approximately seventy-five thousand (75,000) telephones. In Iowa the Independents have over one hundred and eighty-five thousand (185,000), a total of two hundred and sixty thousand (260,000) in the two States; the Bell has only, approximately, eighty thousand (80,000) in the same territory. With Omaha built it will give the Independent Companies at least forty thousand (40,000) additional telephones in the two States in three years, and completes the system in that section.

At the November election, Denver, Colorado, also voted in favor of an Independent franchise. Last summer one was granted at San Francisco, and within the last ten days the Independents have been given a franchise at Milwaukee. These cities with Omaha are the only ones of special consequence, except Cincinnati and Chicago, west of the Ohio River, where the Independents are not strongly intrenched or building. In Chicago a franchise has already been granted and the Independent Company has over forty miles of tunnel under the city streets, this tunnel also being used for hauling freight. The telephone part of this property is controlled by a number of Chicago citizens and railway and telephone interests surrounding the city. It has lately been leased with all franchise rights to a syndicate of well known active Independent operators, who have completed their arrangements to see that it is fully developed, and Independent long distance connections given the numerous cities surrounding the metropolis, who have been clamoring vainly until now for such connections.

Speaking of the Bell Telephone Company, and its "iron grasp" upon the City of Chicago, Corporation Council Lewis said, "Here in this community there is no monopoly which has seized her more ruthlessly, which has ground her more oppressively, or which has more outraged or wronged her people than the telephone company." In the very near future this "ruthless," "grinding," "oppressive" monopoly will be once more forced to reckon with Independent competition, which there is no reason to doubt will bring the same relief to the citizens of Chicago as it has to those of other places.

In other lines of business, competition has been the life of trade; the telephone business has not proved an exception. When the electric light was invented, many of the (artificial) gas companies that had been charging from $3.00 to $4.00 per thousand cubic feet were inclined to believe that their business was ruined. Forced by necessity, they began to study their economies, and by marketing their by-products and the introduction of new devices for the use of fuel gas, they were enabled to develop a day and night load, as well as a winter and summer load, which made it possible for them to reduce the price of gas to an average of $1.00 per thousand cubic feet, bringing it into competition with coal for cooking and heating. To-day there is practically no limit to the amount of light and heat required in this country. So it is with the telephone; there is more business in this country to-day than both systems can properly take care of, and the more rapid their development, the greater will the demand become until every one desiring telephone service has been satisfied—and who can say whether that condition will ever be reached?

There are approximately 7,000,000 telephones connected with both the Independent and Bell exchanges in the United States. If the development throughout the country was as great as in some counties of the central States, it would require at least 14,000,000 telephones, twice the number at present installed. Without competition, there would be less than 2,000,000 telephones in the United States at present; equipment would be crude, rates high, the service unsatisfactory, and the management arbitrary. The small towns and the rural districts and millions of residents and small business men in our cities would be deprived of the greatest convenience

of modern times. Not only has competition as represented by the Independent companies offered lower rates, better service through the use of improved apparatus, more courteous treatment, and developed territory hitherto untouched, but it has forced the Bell to do likewise in sheer self-defence. While installing its own 3,500,000 Independent instruments, competition has compelled the Bell to increase in eleven years to ten times the number of telephones it had in service at the expiration of its more than seventeen years of absolute monopoly.

See what competition has done in your own city. Prior to 1900, when the Keystone Company secured their franchise, you are reported to have had approximately 10,000 telephones; to-day, six years later, you have approximately 70,000 telephones with a superior service and more reasonable rates. The experience in other cities is similar. Cleveland had less than 6,000 telephones when competition was started in 1900, and to-day there are approximately 50,000 telephones; business rates have been reduced from $120.00 to $72.00 per annum; residence rates reduced from $72.00 to $48.00, with party line residence rates as low as $24.00 per annum, thus bringing the telephone within reach of all the citizens. The same results have followed the introduction of competition in all of the cities of any size, while the smaller places and the rural districts were deprived of the service entirely until furnished by the Independents.

I should like to call your attention to the present situation in Canada, where the Independent movement is of very recent growth, and the business still largely a monopoly, conditions analogous to our own a few years ago. I think a study of the situation there will convince the most skeptical that the extensive development of the telephone in the United States is directly due to competition.

Recognizing the necessity for improvement in telephone conditions, the government of Manitoba appointed a select committee to inquire into and report regarding the various telephone systems. A similar committee had been previously appointed by the Dominion Government and had held its sittings in Ottawa; testimony taken before it filled two large volumes of an average of about one thousand pages each. The Manitoba committee, after making a thorough investigation of

its own, and carefully considering evidence presented before the Dominion Committee, reported to their Assembly. This body, after careful deliberation, decided to take the necessary steps to enable the Manitoba Government to construct and operate its own telephone system, and to petition the Canadian Parliament and the Crown to permit the expropriation of the Bell Telephone Company's plant and to refuse an extension to that company's capital. The Honorable Colin Campbell, Attorney General of Manitoba, in a speech before the Assembly, attributed the telephone legislation "To the growth of the Independent telephone companies in the United States, to the costly and limited service of the Bell Telephone Company, and the natural objection of the people of Canada to a monopoly."

The decision of the Committee, as set forth in its report and the debate with reference to the proposed legislation, was that the telephone is a necessary part of civilization, and is such a public utility that it should be operated to serve the people as a whole, and give to every one an opportunity to enjoy its advantages at the lowest cost. It was pointed out that the system of telephones can not be considered complete until every residence, including the farm house in convenient places, has been connected with every other; that the use of the telephone will continue to increase until it has been installed not only in every place of business, but in the home of every citizen. Special stress was laid upon the need of the telephone in the homes of farmers. It was urged that the present rates charged in Canada for telephone service are exorbitant and that a considerable reduction could be made; that the rural telephone system is absolutely neglected and discouraged at present; that the service of the Bell is unsatisfactory and too costly, and that no progress can be looked for from that corporation.

The League of Canadian Municipalities concurs in this view. In a letter to the Postmaster General of Canada, who conducted the inquiry held at Ottawa, the Secretary of the League, in setting forth the views of that body, says: "There is a very widespread conviction, based on what appears to be a solid ground of fact, that the Bell Company's rates are far higher than they ought to be. If my own inquiries into the matter are of any use, and I may say that I have followed it

without any prejudice, weighing many statements and much published matter on both sides, I consider that the progress of the use of the telephone as a home comfort among the mass of our people is immensely retarded by the present virtual monopoly."

In commenting on the progress of the Independent companies in the United States, the Committee reports that "everywhere the entrance of such companies into the field has resulted in the furnishing of satisfactory service at much lower rates than had previously obtained and in the immense extension of the use of the telephone. A noticeable feature of the telephone development in the United States was the large number of long distance lines and lines giving intercommunication in rural districts." The report further states "That it has been demonstrated to the Committee that long distance communications to the South may be easily obtained through the Independent telephone companies in the United States."

It goes on to show that the general result of competition in the United States has been an immense extension of the telephone in all directions, and especially to the farmer, and a great reduction in rates; that in many cases both 'phones could be rented for the price formerly paid for one, and that in places where the charge for both 'phones is higher than for one, it was inconsiderable and more than compensated for by the increased and improved service. Regarding the relative desirability of the single or dual systems, Attorney General Campbell says: "I agree that it is undesirable to have two companies if possible to obviate such conditions, but if we cannot get competition we cannot get a reduction of price, and if we can only get the benefit of competition for the people by entering into the operation of telephones, both as a province and as municipalities, I think we would be justified in so doing."

Among the evidence considered by the Committee were communications from business men regarding the actual working of telephone competition. The following is a summary of 1400 answers from 189 exchanges in the United States to five questions addressed by an American banker to leading business men at such places. This evidence is valuable, coming, as

it does, from our fellow-citizens who are users of the telephone:

Question 1. Has competition resulted in better telephone service in your city? (a) As given by the independent telephone company? Answers—Affirmative, 1,245; negative, 26.

(b) By an improved service on the part of the Bell Co.? Answers—Affirmative, 982; negative, 154.

Question 2. Has competition increased the number of telephone subscribers? Answers—Affirmative, 1,251; negative, 8.

Question 3. Has competition brought about greater civility and more courteous attention to the wants of the subscribers? Answers—Affirmative, 1,222 negative, 37.

Question 4. Have rates for telephone service been reduced by the advent of competition? (a) By the reduction of Bell rates formerly charged? Answers—Affirmative, 979; negative, 120.

(b) By the establishment of rates by the independent company lower than formerly prevailed? Answers—Affirmative, 1,236; negative, 45.

Question 5. In your judgment, would it be preferable to return to the conditions prevailing before the advent of the independent company? Answers—No, 1245; yes, 14.

Of this last fourteen, all but five qualified their answers, favoring a return to a single system only upon condition that they would be given the same service as they were now receiving and at the same price. Many of the other answers were very emphatic in opposing a return to conditions existing before competition.

The Manitoba Government, recognizing the futility of attempting to secure better telephone conditions from the Bell, is determined to establish a governmental system, and will endeavor to obtain the power to expropriate the Bell plant; should this be denied, however, it will nevertheless, if the people approve of the policy, build its own lines and exchanges, believing that competition will accomplish the desired results, as it has in the United States.

The Union of Manitoba Municipalities at a meeting last week, after spending two days in listening to testimony from telephone experts and officers, and then devoting a half day to discussion, at the close of its session, by a vote of eighty-six (86) to nineteen (19), passed a resolution recommending the municipalities in the Province to put in their own telephone systems in competition with the Bell. As already stated, telephone competition in Canada is practically in its infancy. The

Bell Telephone Company had made exclusive contracts with many of the railways and other corporations, some of which are now expiring. This, prior to the last two years, had made it almost impossible for the Independent companies to obtain a foothold. At the close of 1904 the Bell had approximately one telephone for every ninety (90) inhabitants. Their last report shows 78,195, or one to every seventy (70) inhabitants. The Independent companies in the meanwhile have installed 12,500 telephones, and everything indicates that they will make a gain of 200% in the coming year. In the State of Indiana, which has a population of approximately one-half of the Dominion of Canada, there is one Independent telephone for every fourteen persons, and in that State the Independents outnumber the Bell about three to one.

The Independent telephone interests to-day have a good organization, known as the International Independent Telephone Association of America. The organization formed in Detroit in 1897 for the purpose of defending damage cases brought by the Bell, finished its work by winning the last of the patent cases in 1904. In 1905 the Association was re-organized in Chicago under what is known as the "Ohio Plan." This plan starts with an organization in each State, which usually divides it into districts to suit local conditions, each of the districts having a complete organization of its own, subject to the control of the State body. The various companies are represented on the basis of the units they operate, a unit being one telephone or circuit mile of toll line. The district organizations select delegates to the annual meeting of the State Association on the basis of one representative for every one thousand units operated by their members. One delegate to the International Convention is allowed for each 10,000 units in the State. Each district selects a delegate to this Convention, the remainder necessary to make up the full quota being elected at the State meeting as delegates-at-large. At the district meetings all questions with reference to traffic conditions between the companies, the development of territory, etc., are considered. At the State meetings matters of general importance to the movement in the State are taken up.

The International Association holds its annual Convention between May 1st and July 1st. Permanent headquarters are

maintained in Cleveland, where a corps of secretaries and a map maker are employed for the purpose of keeping in touch with the development in the various States. At present there are over 7,000 Independent companies operating in over 12,000 cities and villages.

Our plan of organization is not a new one; it is based upon the Federal plan of Government, which has been in use in the counties, Congressional districts and States of the Union for more than a century. I believe it was Benjamin Franklin who first proposed a plan of this kind in 1754. It was known as the Albany plan, and outlined the formation of a separate government in each of the colonies, to be brought together in a central government for all of the united colonies. The plan under which our Association is operating seems broad enough to cover every possible contingency in keeping the Independent interests working together in harmony and as a complete system. It is often difficult for those not interested in the Independent telephone business to understand the enthusiasm of the people engaged in it. It is more than a mere means of livelihood to them; it is a *cause*, something worth fighting for. Perhaps this is true of any particular line of effort, but in no others I think to such an extent as in the Independent telephone business. This feeling is probably due in a measure to the interest attaching to the development of the industry, but more, I believe, to the conviction of practically all engaged in it that they are doing their part in a movement to benefit mankind. This feeling was never better expressed than by Judge Robert S. Taylor, who was appointed by President Cleveland to represent the United States Government in the famous Berliner patent case. Judge Taylor, in addressing a meeting at Chicago last summer, said: "I have never done anything in my life which I did with so much heart and so much earnestness as the fights I have made for Independent Telephony. I have never done anything I have felt so well satisfied with. I have always considered that no movement in this country that has ever taken place carried with it so much of a blessing to the people as the Independent telephone movement."

Aside from its many commercial and social advantages, the telephone has performed a very important part in advancing civilization, and there is little doubt that there would be much

more crime in the United States to-day were it not for the extensive use of the telephone. This, I think, is particularly true of the rural districts. The use of the telephone has lessened profanity; it is seldom that a profane word is heard over the wire; it has broadened all who use it to any extent in the choice of their language; something seems to prompt people using the telephone to talk their best. Of course, there are exceptions, but very little investigation on the part of any one will demonstrate the general truth of the statements just made.

There are to-day and will continue to be two great telephone systems; one, as at present, controlled and operated as a trust; the other, the Independent, operated as a complete system, reaching practically every farmer, all of the towns, and every important business center in the United States and Canada. The control of the securities and the management of the various companies making up this system to remain with local people. Consolidations will undoubtedly be made here and there to bring these companies into convenient groups, which in many cases will be county groups or Congressional District groups, tributary to large centers, reaching out a distance of fifty to one hundred miles. In my judgment, and I am by no means alone in this view, it would be unwise to consolidate them as one system, if, indeed, such a thing was possible. The telephone business is very largely a business of detail and requires the most careful management. This management must be in close touch with the other business interests of a community. No community can afford to depend upon a monopoly to supply its telephone service for the following reasons and many more that might be enumerated:

Competition: First—Guarantees fair rates.
Second—Secures at least fair management and courteous treatment from both systems.
Third—Stimulates the best thought of inventive minds in improving the apparatus, and the careful study of operating conditions with a view to greater efficiency.

Another advantage of competition—and I wish to call special attention to this because it is so often overlooked by the champions of a single system—is the almost absolute assurance it offers to the subscribers of both systems against being

deprived, by accident, of their telephone service. Even if the 70,000 telephones in your city were controlled by one company, many of your business men would still be compelled to have at least two telephones to take care of their business. In case of exchange trouble, fire, strikes, cable or line trouble in any particular section, you might be completely deprived of the use of your telephones until such trouble had been cleared. With instruments connected to both exchanges, the chances for this are almost entirely obviated. It is very seldom that both of your instruments will be out of order at once. The advantage of this until demonstrated by actual experience, as it has been in many cases, is not generally appreciated.

The increase in the use of the telephone has so far exceeded the anticipation of the most optimistic that it is hard to predict what it will be in the future. It is estimated that the United States will have a population of 200,000,000 in 1950; that population will require at least 50,000,000 telephones, more than seven times the present number. The telephone while increasing in usefulness will also be made a still greater means of pleasure and entertainment, and will be utilized for the transmission of concerts, sermons, political addresses, etc.; in fact, the Keystone Telephone Company of your city is now experimenting with such service.

Already the "seeing telephone," as exemplified in the "Televue," has been invented by J. B. Fowler, of San Diego, California. Long before 1950 this or a similar device will have been perfected, and by means of it, one may not only converse over the telephone, but actually *see* the person with whom he is speaking. Through the use of such a device, the police department will be able to transmit not only the description, but the photograph of a criminal wanted and to identify one instantly no matter where captured. Think of the convenience of shopping by telephone when one can not only order but view the goods purchased. When the telephone has been brought to its highest stage of usefulness, as our friend, Mr. Dooley, remarks, "th' legs will be as good f'r nawthin' as the appendix."

This talk would be incomplete without some reference to Independent telephone securities, for the progress of any industry, no matter how useful, depends upon its ability to show

proper returns upon the capital invested and to secure the capital necessary to its development. There is no reason to believe the Independent movement will be hampered through this cause. Already its securities are being favorably regarded by investors everywhere and they will, beyond question, in the very near future take their place on a par with the securities of other public serving corporations. There is no other utility which is in greater demand than the telephone, and statistics prove that panics have less effect on the gross income of wire using companies than on any others. It has been demonstrated that subscribers will economize, not only in luxuries but in their very necessities, in every way possible before giving up the telephone, and the telephone will continue to increase in usefulness and become a greater benefit and a more absolute necessity than at present. Thus the securities of the Independent telephone companies offer a safe and remunerative form of investment, and this fact thoroughly appreciated, there will be no lack of funds to develop the industry.

Telephony is desirable as a career for the young man. The electrical field is a broad one and experts do not believe that we have more than commenced to develop it. The telephone branch of the business offers peculiar advantages and attractions. With the marvelous growth there will come a demand for thousands of well trained young men in this field of labor. Already telephone courses have been established at universities and colleges, and the demand for some of the technically trained students is so great that employment is offered them before they have finished their course. As telephony prosgresses the men with technical training will be more and more in demand. I, therefore, commend this branch of the electrical field to the students of all technical schools as one worthy of their consideration. They will find that it not only offers them employment but will give them splendid opportunities for careful study and the development of economies and new improvements that will result in financial benefit to themselves and be of untold advantage to mankind.

Section of Physics and Chemistry.

(Stated meeting held Thursday, January 10th, 1907.)

The Analysis of Chalybeate Waters.*

By C. Chester Ahlum.

Chalybeate waters may be those containing ferrous carbonate held in solution by carbonic acid, or those containing iron sulphates, the latter substances being the product of oxidation of iron pyrites encountered by the water. Sulphuric acid is another product of the oxidation and will also be found in the water.

If the water containing these substances comes in contact with limestone, calcspar or dolomite another reaction takes place, namely, the sulphuric acid will decompose these minerals with the formation of calcium and magnesium sulphates and carbon dioxide, hence becoming heavily charged with these substances in addition to the iron sulphates.

The presence of the iron sulphates is very detrimental to steam-boilers, and in the bituminous coal regions of Western Pennsylvania great difficulty is experienced by some mine operators in obtaining a supply of water fit for steam producing. In a certain locality many wells have been driven, but in nearly every instance they were found to be absolutely worthless, being heavily charged with sulphuric acid, calcium, magnesium and iron sulphates, the latter very often to the extent of 500 grains per gallon.

To treat a water of this character for boiler purposes is utterly impossible, and some operators are obliged to haul water five or six miles from a better source.

*Read by title.

Because of the readiness with which iron undergoes oxidation from the mere presence of air, we will find it in both conditions, ferrous and ferric, and therefore the regular method of analysis will require modification.

The method employed by the writer is as follows:—

Iron oxide and alumina.—200 c.c. of the filtered water are boiled down to 50 c.c. after acidifying with hydrochloric acid and adding 2 c.c. of concentrated nitric acid. Ammonium hydroxide is added until the iron and alumina is completely precipitated. It is then filtered off, washed, dried, ignited and weighed as $Fe_2O_3 + Al_2O_3$.

The residue in the crucible is dissolved in a very small quantity of hydrochloric acid. The solution is then transferred to a 250 c.c. erlenmeyer flask containing 50 c.c. of water and 5 c.c. of concentrated sulphuric acid. The iron in solution is reduced to the ferrous state in the ordinary way using metallic zinc and after being reduced is then titrated with N/10 potassium permanganate.

The amount of iron obtained from the titration is deducted from the total weight of the iron oxide and alumina, giving the weight of the alumina present in the combined precipitate.

Calcium oxide.—To the filtrate from the iron oxide and alumina is added in slight excess a strong solution of ammonium oxalate. After standing for twelve hours the precipitate is filtered off, washed with water and dissolved in moderately strong sulphuric acid, which is then titrated with N/10 potassium permanganate.

Magnesium oxide.—To the filtrate from the calcium oxalate is added a small quantity of ammonium hydroxide and then a solution of disodium hydrogen phosphate. After standing twelve hours the precipitate is filtered off and washed with a mixture of 1000 c.c. of water, 500 c.c. of ammonium hydroxide and 150 grams of ammonium nitrate. The precipitate is then ignited and weighed as $Mg_2P_2O_7$.

Sulphur trioxide.—200 c.c. of the filtered water are acidified with hydrochloric acid and heated to boiling. Barium chloride is then added in slight excess and allowed to stand until the precipitate has settled. It is then filtered off, washed, dried, ignited and weighed as $BaSO_4$.

Chlorine.—100 c.c. of the filtered water are acidified with

nitric acid and silver nitrate added in slight excess. The liquid is brought to a boil, filtered, washed, dried, ignited and weighed as AgCl.

Silica, sodium and potassium oxides.—500 c.c. of the filtered water are evaporated to dryness in a platinum dish on a water bath, treated with dilute hydrochloric acid and again evaporated to dryness. The residue is then extracted with a little dilute hydrochloric acid, the insoluble silica filtered off, dried, ignited and weighed as SiO_2.

To the filtrate is added in slight excess, a solution of barium hydroxide. The liquid is then boiled, filtered and washed, and to the filtrate is added a few drops of ammonium hydroxide, then a solution of ammonium carbonate as long as a precipitate forms. The solution is allowed to stand for some time, stirring occasionally until the precipitate becomes granular. It is then filtered and the precipitate washed with water containing a few drops of ammonium hydroxide and a very small quantity of ammonium carbonate. The filtrate after being acidified with a few drops of hydrochloric acid, is evaporated to dryness in a platinum dish over a water bath. The dish containing the residue is then heated to about 140° in an air bath, and then heated to dull redness over a burner to expel ammonium salts.

The residue is then dissolved in 10 c.c. of water, a few drops of barium hydroxide are added, then a few drops of ammonium hydroxide, and finally is added in excess a solution of ammonium carbonate. After allowing to stand for some time it is filtered and the precipitate washed with water containing a few drops of ammonium hydroxide and a small quantity of ammonium carbonate.

The filtrate is then evaporated to dryness after acidifying with hydrochloric acid. The dish with the residue is heated to 140° in an air bath and then a dull redness over a burner to expel ammonium salts. It is then cooled in a desiccator and weighed as NaCl + KCl.

The residue is redissolved in 10 c.c. of water and to the solution is added a drop of hydrochloric acid and then platinic chloride in excess. It is then evaporated nearly to dryness, 20 c.c. of alcohol are added, and after all the red sodium salt is dissolved, is filtered on a tared filter, washed with alcohol, dried and weighed as K_2PtCl_6.

This weight multiplied by .30701 gives the weight of potassium chloride which, when subtracted from the weight of the mixed chlorides, gives the weight of sodium chloride.

Iron in ferrous condition.—200 c.c. of the filtered water are acidified with about 10 c.c. of concentrated sulphuric acid and titrated with N/10 potassium permanganate.

Total solids.—100 c.c. of the filtered water are placed in a weighed platinum dish and evaporated to dryness on a water bath. The dish with the residue is dried at 100°, cooled and weighed. The residue is dissolved out quickly with dilute sulphuric acid and titrated with N/10 potassium permanganate.

In reporting the analyses with the bases and acids expressed in their probable combination, the following rule is followed:—The chlorine is combined with the sodium and if in excess with the potassium, then with magnesium and finally calcium, iron and aluminum, in the order named. The sulphur trioxide is combined with the sodium first, if there was not enough chlorine to satisfy this base, then with potassium and finally calcium, magnesium, aluminum and iron, in the order named. The calcium and magnesium in excess are calculated to carbonates and any iron alumina in excess as iron oxide or alumina.

To show the method in detail, the following analysis is given:—

Weight of total solids	.8123	grams	(100 c.c. of water)
" " $Fe_2O_3+Al_2O_3$	.5214	"	(200 c.c. of water)
" " $BaSO_4$	2.4806	"	(200 c.c. of water)
" " AgCl	.0137	"	(100 c.c. of water)
" " $Mg_2P_2O_7$	.1312	"	(200 c.c. of water)
" " SiO_2	.0131	"	(500 c.c. of water)
" " NaCl+KCl	.3552	"	(500 c.c. of water)
" " K_2PtCl_6	.0182	"	(500 c.c. of water)

Titration.—Iron in ferrous state, 60.1 c.c. of N/10 potassium permanganate (200 c.c. of water).

Titration.—Iron in ferrous state after evaporation, 23.2 c.c. of N/10 potassium permanganate (100 c.c. of water).

Titration—Calcium oxalate, 18.1 c.c. of N/10 potassium permanganate.

Titration.—Iron from the mixed precipitate $Fe_2O_3+Al_2O_3$—62.5 c.c. of N/10 potassium permanganate.

Factors.

1 c.c. of potassium permanganate = .0072 grams FeO
1 c.c. " " " = .0080 " Fe_2O_3
1 c.c. " " " = .0038 " CaO
1 c.c. " " " = .0008 " Oxygen

$BaSO_4$	: SO_3	= .34291	2NaCl	: Na_2O	= .53076
AgCl	: Cl	= .24726	2KCl	: K_2O	= .63183
$Mg_2P_2O_7$	: MgO	= .36190	K_2PtCl_6	: 2KCl	= .30701

The weights of the bases and acids found are corrected to 100 c.c. of water.

Weight of NaCl + KCl ..... .3552
Weight of KCl = .0182 × .30701 = ... .0056

Weight of NaCl ..... .3496
Weight of Na_2O in 100 c.c. of water.....(.3496 × .53076) ÷ 5 = .0371
Weight of K_2O in 100 c.c. of water.....(.0056 × .63183) ÷ 5 = .0007

Weight of $Fe_2O_3 + Al_2O_3$ ..... .5214
Weight of Fe_2O_3 from titration ..... .5000

Weight of Al_2O_3 ..... .0214
Weight of Fe_2O_3 in the mixed precipitate.....62.5 × .008 = .5000
Fe_2O_3 in 100 c.c. of water..... .5000 ÷ 2 = .2500
Al_2O_3 in 100 c.c. of water..... .0214 ÷ 2 = .0107

Weight of MgO in 100 c.c. of water .....(.1312 × .3619) ÷ 2 = .0237
Weight of Cl in 100 c.c. of water ..... .0137 × .24726 = .0033
Weight of SiO_2 in 100 c.c. of water ..... .0131 ÷ 5 = .0026
Weight of CaO in 100 c.c. of water .....(18.1 × .0028) ÷ 2 = .0253
Weight of SO_3 in 100 c.c. of water .....(2.4806 × .34291) ÷ 2 = .4253
Weight of FeO in 100 c.c. of water .....(60.1 × .0072) ÷ 2 = .21636
.21636 grams of FeO = .2404 grams of Fe_2O_3
Weight of Fe_2O_3 in 100 c.c. of water ..... .2500 — .2404 = .0096

Correction of the total solids.—When the water is evaporated to dryness on the water-bath, oxygen will be absorbed by the ferrous salts during the exposure to the air. The amount of oxygen absorbed is determined by the difference in the amount of N/10 potassium permanganate required by the ferrous salts before evaporation and the amount required after.

(60.1 ÷ 2) = 30.0 c.c. N/10 $KMnO_4$ required by the ferrous salts in 100 c.c. before evaporation.
23.2 c.c. N/10 $KMnO_4$ required by the ferrous salts in 100 c.c. after evaporation.
6.8 c.c. N/10 $KMnO_4$ difference

The amount of oxygen absorbed from the air is equivalent to

the amount of available oxygen of the N/10 potassium permanganate.

Weight of solids	.8233
Weight of oxygen absorbed (6.8 × .0008)	.0054
Weight of corrected solids	.8179
Weight of free H_2SO_4 (see next page)	.0256
Weight of corrected solids (final)	.7923

The free sulphuric acid will go into combination during the oxidation and will therefore increase the weight of solids.

Collecting the results we obtain the following:—

	grams per. 100 c.c.	grams per. 1000 c.c.
Sodium oxide	.0371	.3710
Potassium oxide	.0007	.0070
Calcium oxide	.0253	.2530
Magnesium oxide	.0237	.2370
Ferrous oxide	.2164	2.1640
Ferric oxide	.0096	.0960
Alumina	.0107	.1070
Sulphur trioxide	.4253	4.2530
Chlorine	.0033	.0330
Silica	.0026	.0260

Carrying out the rule of combining the acids and bases we obtain the following:—

	grams per. 1000 c.c.
Sodium chloride	.0540
Sodium sulphate	.7190
Potassium sulphate	.0130
Calcium sulphate	.6150
Magnesium sulphate	.7110
Aluminum sulphate	.3580
Ferrous sulphate	4.5680
Ferric sulphate	.2400
Silica	.0260
Organic, etc.	.6190
Total solids	7.9230
*Sulphuric acid (free)	.2560

*Because of the presence of sodium chloride, part of the free acid may be expressed as hydrochloric if preferred. The amounts of sulphuric acid, sodium sulphate and chloride will therefore require correction. For direct estimation of free acid see 470-473 J. Chem. Soc. (London), Vol. 89.

With waters containing ferrous carbonate, the regular methods of analysis are followed and any iron that has become oxidized is stated as ferric oxide. The ferrous iron is estimated by standard potassium permanganate.

Laboratory of Geo. W. Lord Company, Philadelphia.

DESTRUCTIVE FLOODS IN 1905.

The destructive floods that occurred in the United States during 1905 are described by Mr. Edward Charles Murphy and other hydrographers of the United States Geological Survey in a recent publication of that bureau, which is listed as Water-Supply and Irrigation Paper No. 162. The very destructive floods of that year were few. The most remarkable flood or series of floods of the year were those in Gila River Basin, in Arizona. From January 15 to April 30 occurred a series of seven floods—almost a continuous flood—remarkable for the total volume of flow. In November there was in this basin another flood, which was notable for its magnitude, being the largest on record on Salt River. The other large floods of the year occurred on comparatively small streams. Few lives were lost and the damage was small compared with that of some previous years.

Among the floods described in this paper are those on Poquonnock River, Connecticut, on Sixmile Creek and Cayuga Inlet, New York, on the Unadilla and Chenango Rivers, New York, on Allegheny River, Pennsylvania-New York, on Devil's Creek, Iowa, on Purgatory River, Colorado, on Pecos River, New Mexico-Texas, on Hondo River, New Mexico, on Rio Grande, New Mexico-Texas, in Colorado River Basin and in Gila basin.

A discussion of the flood discharge and the frequency of floods in the United States together with an index to the literature of American floods adds to the value of this paper. Maps and views to the number of fifteen are included. Besides Mr. Murphy, the chief contributors to the paper are Messrs. T. W. Norcross, R. E. Hotron, C. C. Covert, and F. W. Hanna. It is published for free distribution, and application for it should be made to The Director of the United States Geological Survey, Washington, D. C.

PRODUCTION OF SILVER IN 1905.

The production of silver increased in quantity from 55,999,864 ounces in 1904 to 56,101,594 ounces in 1905, a gain of 101,730 ounces; but it increased in commercial value from $32,035,378 in 1904 to $34,221,972 in 1905, a gain of $2,186,594.

PRODUCTION OF GOLD IN 1905.

The production of gold in the United States increased from 3,910,729 ounces, valued at $80,835,648, in 1904, to 4,265,742 ounces, valued at $88,180,711, in 1905, an increase of 355,013 ounces in quantity, and of $7,345,063 in value.

REPORTS OF STREAM MEASUREMENTS.

The last of the fourteen papers covering the progress of stream measurements for the calendar year 1905 has recently been issued by the United States Geological Survey, so that the series is now complete. They are listed under the head of Water Supply and Irrigation Papers and range in number from 165 to 178 inclusive. The region covered in each paper is indicated by subtitles, which are as follows:

165. Atlantic coast of New England drainage.

166. Hudson, Passaic, Raritan and Delaware River drainages.

167. Susquehanna, Gunpowder, Patapsco, Potomac, James, Roanoke, and Yadkin River drainages.

168. Santee, Savannah, Ogeechee, and Altamaha Rivers and eastern Gulf of Mexico drainages.

169. Ohio and lower eastern Mississippi River drainages.

170. Great Lakes and St. Lawrence River drainages.

171. Hudson Bay and upper eastern and western Mississippi River drainages.

172. Missouri River drainage.

173. Meramec, Arkansas, Red and lower Western Mississippi drainages.

174. Western Gulf of Mexico and Rio Grande drainage.

175. Colorado River drainage above Yuma.

176. Great Basin drainage.

177. Great Basin and Pacific Ocean drainages in California, and Colorado River drainage below Gila River.

178. Columbia River and Puget Sound drainages.

A limited number of these papers are held by the Geological Survey for free distribution, and a number have been delivered to Senators and Representatives in Congress for free distribution. Applications sent to the Survey should be addressed to The Director, United States Geological Survey, Washington, D. C.

MODERN BATTLESHIP CONSTRUCTION.

Owing to the developments of the Japanese sea force and the lead of England in the matter of battleship construction of great size, other nations are joining in the race for supremacy in the single battle unit. The English type ship Dreadnaught is of 18,500 tons displacement. Japan is building two, in native dockyards, of 19,500 tons each. Germany has two of 19,000 tons under contract. France has taken steps looking to the acquisition of six of 18,000 tons each. The United States has one under authorization to displace probably 20,000 tons. At present writing there seems to be little disposition to limit the size of new constructions; the whole tendency is a reaching out into new fields of size and character, a general disposition to relegate medium-sized guns to the scrap heap being the most prominent individual characteristic of the new ships. Speeds are being raised above those of previous types, which multiplies largely the construction of each unit.—*Iron Age.*

(Stated meeting held Thursday, October 11th, 1906.)

Tax-Free Alcohol.*

By Albert P. Sy,

University of Buffalo.

On account of its relation to many important industries in the United States, especially its relation to chemical manufacturing, its use for light and heat, its use in gas engines, the subject of tax-free alcohol becomes of great importance, and for this reason has been much discussed and much has been written about it lately. It is believed that a short review of the alcohol industry might be of interest to the readers of this *Journal*.

After about eighteen years of attempted legislation in this direction there has been passed by the House of Representatives and the Senate and signed by the President a bill which becomes operative in 1907 and which removes the internal revenue tax on grain alcohol.

On account of its importance, the text of the new law is herewith given in full, as follows:

THE "FREE ALCOHOL" LAW.

Below is presented the text of the new law providing for tax-free denatured alcohol for use in the arts and industries, but not in the manufacture of beverages or liquid medicines:

AN ACT

For the withdrawal from bond, tax free, of domestic alcohol when rendered unfit for beverage or liquid medicinal uses by mixture with suitable denaturing materials.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That from and

*Read by title.

after January 1st, 1907, domestic alcohol of such degree of proof as may be prescribed by the Commissioner of Internal Revenue, and approved by the Secretary of the Treasury, may be withdrawn from bond without the payment of internal revenue tax, for use in the arts and industries, and for fuel, light, and power, provided said alcohol shall have been mixed in the presence, and under the direction, of an authorized government officer, after withdrawal from the distillery warehouse, with methyl alcohol or other denaturing material or materials, or admixture of the same, suitable to the use for which the alcohol is withdrawn, but which destroys its character as a beverage, and renders it unfit for liquid medicinal purposes; such denaturing to be done upon the application of any registered distillery, in denaturing bonded warehouses specially designated or set apart for denaturing purposes only, and under conditions prescribed by the Commissioner of Internal Revenue, with the approval of the Secretary of the Treasury. The character and quantity of the said denaturing material and the conditions upon which said alcohol may be withdrawn free of tax shall be prescribed by the Commissioner of Internal Revenue, who shall, with the approval of the Secretary of the Treasury, make all necessary regulations for carrying into effect the provisions of this Act.

Distillers, manufacturers, dealers and all other persons furnishing, handling or using alcohol withdrawn from bond under the provisions of this Act shall keep such books and records, execute such bonds and render such returns as the Commissioner of Internal Revenue, with the approval of the Secretary of the Treasury, may by regulation require. Such books and records shall be open at all times to the inspection of any internal revenue officer or agent.

Section 2. That any person who withdraws alcohol free of tax under the provisions of this Act and regulations made in pursuance thereof, and who removes or conceals the same, or is concerned in the removing, depositing or concealing the same for the purpose of preventing the same from being denatured under governmental supervision, and any person who uses alcohol withdrawn from bond under the provisions of Section one of this Act for manufacturing any beverage or liquid medicinal preparation, or knowingly sells any beverage or liquid medicinal preparation made in whole or in part from such alcohol, or knowingly violates any of the provisions of this Act, or who shall recover or attempt to recover by redistillation or by any other process or means, any alcohol rendered unfit for beverage or liquid medicinal purposes under the provisions of this Act, or who knowingly uses, sells, conceals, or otherwise disposes of alcohol so recovered or redistilled, shall on conviction of each offense be fined not more than $5,000, or be imprisoned not more than five years, or both, and shall in addition, forfeit to the United States all personal property used in connection with his business, together with the buildings and lots or parcels of ground constituting

the premises on which said unlawful acts are performed or permitted to be performed: Provided, That manufacturers employing processes in which alcohol used free of tax under the provisions of this Act, is expressed or evaporated from the articles manufactured, shall be permitted to recover such alcohol and to have such alcohol restored to a condition suitable solely for reuse in manufacturing processes under such regulations as the Commissioner of Internal Revenue, with the approval of the Secretary of the Treasury, shall prescribe.

Section 3. That, for the employment of such additional force of chemists, internal revenue agents, inspectors, deputy collectors, clerks, laborers, and other assistants as the Commissioner of Internal Revenue, with the approval of the Secretary of the Treasury, may deem proper and necessary to the prompt and efficient operation and enforcement of this law, and for the purchase of locks, seals, weighing beams, gauging instruments, and for all necessary expense incident to the proper execution of this law, the sum of $250,000, or so much thereof as may be required, is hereby appropriated out of any money in the treasury not otherwise appropriated, said appropriation to be immediately available.

For a period of two years from and after the passage of this Act the force authorized by this Section of this Act shall be appointed by the Commissioner of Internal Revenue, with the approval of the Secretary of the Treasury, and without compliance with the conditions prescribed by the Act entitled "An Act to regulate and improve the civil service," approved January 16th, 1883, and amendments thereof, and with such compensation as the Commissioner of Internal Revenue may fix, with the approval of the Secretary of the Treasury.

Section 4. That the Secretary of the Treasury shall make full report to Congress at its next session of all appointments made under the provisions of this Act, and the compensation paid thereunder, and of all regulations prescribed under the provisions hereof, and shall further report what, if any, additional legislation is necessary, in his opinion, to fully safeguard the revenue and to secure a proper enforcement of this Act.

A bill in one form or another, for the purpose of obtaining tax-free alcohol had been introduced many times previously, but other interests were so strong that these bills never came out of the committees to whom they were referred. The chief opponents were those interested in mineral oils (gasolene, kerosene, etc.,) and the manufacturers of wood alcohol. The mineral oil industry, which is controlled by the Standard Oil Co., which is one of the most powerful and gigantic trusts or monopolies in the world, saw in tax-free alcohol a serious competitor. The same is true of the wood alcohol manufacturer,

whose product, being tax-free, can be sold at a considerably lower price than grain alcohol and still bring an enormous profit. Of course those interested in wood alcohol could readily see that with no tax on grain alcohol, wood alcohol could not compete with it, since it costs more to produce the wood alcohol. While the bill which has just been passed was under consideration, the wood alcohol manufacturers brought great pressure to bear against it; they appeared repeatedly before the committee, urging that the entire wood alcohol industry, which is quite extensive, would be ruined, and many workmen would be thrown out of employment. Their principal argument against tax-free alcohol was that there would be an increase in the use of alcoholic beverages and consequently an increase of drunkenness and misery. However one can easily see the weak points in all these arguments. It does not follow that tax-free grain alcohol would ruin the wood alcohol industry, since there are a great many purposes for which wood alcohol would still be used in preference to denatured grain alcohol. There will be considerable demand for the former for denaturing purposes, in fact it is estimated that the present output of wood alcohol will not be sufficient to supply the demand for denaturing purposes. Wood alcohol is necessary for making formaldehyde. While perhaps a comparatively few workmen would be thrown out of employment at first as a result of the decrease in demand for wood alcohol, yet thousands of others would find employment in the grain alcohol industry, not only those directly connected with the distilleries, but those who produce the raw materials, would require extra help.

The denaturing materials are not mentioned in the bill, but the commissioner will no doubt follow the customs of other countries and use crude wood alcohol and some product containing pyridine bases. This would leave the alcohol best suited for most purposes and at the same time effectively produce a disgusting flavor and make it poisonous. Prominent chemists testified before the committee that illicit recovery is impossible without distillation, and even then it is difficult. The wood alcohol manufacturers attempted to show that illicit recovery is easy, but investigation convinced them that such is not the case. The writer of this made several series of experiments which showed that even a partial and unsatisfactory

recovery is exceedingly difficult, and in most cases impossible.

All other nations of commercial importance allow the use of alcohol in the arts and for industrial purposes tax free. One of the reasons why previous legislation for tax-free alcohol has failed in the United States is that it was thought that on account of the high tax on alcohol for beverages there would be great temptation for fraud upon the revenue. In the past the question has also been misunderstood with reference to the use of alcohol for medicines; if alcohol were to be used tax-free for medicinal compounds there would be great difficulty in guarding the revenue. For this reason the original bill was changed so as to eliminate the clauses relating to the use of tax-free alcohol for medicines. While it is believed by some that there will be fraud upon the revenue, yet other countries have had no difficulty in this respect. The Secretary of the Treasury and the Commissioner of Internal Revenue both agree that the new bill can be enforced and fraud avoided. There are at present two exemptions for tax on alcohol, namely, for fortifying wines and for making vinegar, and the Commissioner reports that there is practically no fraud upon the revenue under these exemptions.

It will not be necessary to give details of manufacture of either wood or grain alcohol, except to mention the fact that in the United States grain alcohol is made mostly from starchy grains instead of from potatoes as in Germany and some other countries. The grain usually used is maize or Indian corn. Of this there is grown an enormous amount in the United States annually, and with an increased demand for alcohol, the production of corn as well as other grains and vegetables will be greatly increased, and agricultural conditions will be greatly benefitted by the new bill.

With reference to the cost of production of grain alcohol, the following points were brought out before the committee, the data being obtained from the books of a large distillery in Peoria, Illinois: The average price paid for corn for ten years was 42.36 cents per bushel; the average amount of alcohol from a bushel of corn was 4.76 proof gallons (50%); the average cost of a proof gallon was 10.78 cents. The cost of corn for one proof gallon was 8.89 cents; subtracting this 8.89 from the total cost, 10.78, there is left 1.89 cents as the cost of

making one proof gallon of alcohol. At this rate it would cost 3.4 cents per gallon to make 90% alcohol, or a total cost of 19.4 cents per gallon, including the corn. Lately the methods for producing alcohol have been improved so that about 5 proof gallons can be made from one bushel of corn, or the total cost of a gallon of 90% alcohol is 18.4 cents.

With reference to the amount of alcohol that may be produced from corn and potatoes, Secretary Wilson, of the Department of Agriculture, said that one acre will produce (average) 50 bushels of corn from which there can be made 882 pounds of absolute alcohol, or about 130 gallons, which corresponds to about 140 gallons of 95% alcohol. One acre will produce 18,000 pounds of potatoes, from which 1620 pounds of absolute alcohol or 255 gallons of 95% alcohol can be made.

Before the same committee a representative of farmers organizations said that with corn at 30 cents a bushel, yielding 2.5 gallons of 95% alcohol, the total cost of making one gallon would be about 12 cents a gallon, and could be sold for 20 cents a gallon.

An enormous amount of starchy material goes to waste annually in the stalks of the corn, i. e., in the plant itself, which in most cases is not removed from the land. With commercially practical methods for recovering and utilizing this waste, the production of alcohol per acre of corn can be greatly increased. The Department of Agriculture has been making experiments, using corn cobs and stalks for making alcohol; it is believed that this will develop into an industry of considerable commercial importance. These materials have heretofore been allowed to go to waste. Experiments made at Hoopeston, Ill., in the corn district of that State, have shown that sufficient alcohol can be recovered from these raw materials to justify the erection of a distilling plant. According to reports, eleven gallons of alcohol have been obtained from a ton of green cobs, while a ton of green stalks yielded six gallons.

Another important source of alcohol is the low grades of molasses, those grades that can not be sold as molasses. In Central and Southern America and the West Indies there are produced annually millions of gallons of low grade molasses, which at present are burned, destroyed or fed to animals; a small proportion is brought to this country to be worked up

into liquors. While this material is much cheaper than corn as a source of alcohol, it produces an alcohol which is unfit for making beverages on account of the odor and taste which it derives from the molasses. But for industrial purposes where this alcohol can be used tax-free this odor and taste are no objections. On account of its cheapness, this molasses is considered by some as the most important source of alcohol at present not developed.

In Cuba alcohol is now made from this molasses at a cost of 10 cents per gallon according to a report of United States Minister Squires. In the United States this molasses can be bought for 3 cents per gallon, and it takes about 2 gallons to make a gallon of alcohol; with a cost of 3.4 cents per gallon for making, 90% alcohol from this source would cost 9.4 cents to produce.

Another source of alcohol is the low grade molasses produced in the manufacture of sugar from beets. Ten factories in the State of Michigan produced enough of this molasses which was converted into one million proof gallons of alcohol in a distillery in that State. While at present the beet sugar industry is still in its infancy, it is obvious that with its development this will furnish a byproduct of importance in the alcohol industry.

The pulp of the coffee berry, which was formerly a waste product, is now used in Mexico and South America for making alcohol.

The total cost of production of a gallon of wood alcohol is greater than that of a gallon of grain alcohol, but with no internal revenue tax on the former, it could be sold considerably cheaper than the latter and still leave a big profit. At present the prices of the various grades of wood alcohol, according to quotations from the Wood Products Co., of Buffalo, N. Y., are as follows:

95% alcohol, 80 cents per gallon, or 70 cts. in barrel lots.
97% " 90 " " " " 75 " " " "
Columbian Spirits (99%) $1.35 " " " $1.25 " " "

Many chemical manufacturing interests will be greatly benefitted by tax-free alcohol, and much is hoped for in the development of our chemical industries in the near future. Denaturated alcohol would be used in the following industries

where wood alcohol is chiefly used now: Anilin colors, organic chemicals, transparent soaps, celluloid, smokeless powder, fulminates, photographic materials, and many other manufactories where alcohol is used for finishing and painting.

Methyl alcohol is used to some extent in the manufacture of smokeless powders and explosives, but it is believed by some that a better and more stable product can be made by using grain alcohol; experts in the Ordnance Department of the U. S. Army say that in making smokeless powder a better colloid is produced when grain alcohol is used; the Government requires that smokeless powders made for use in the army shall be made by using grain alcohol free from methyl alcohol. The Ordnance Department of the U. S. Army does not have its own powder manufactory, but the powders are made under contract by private firms; these firms are allowed one pound of alcohol tax-free for every pound of powder which they make for the Government. Tax-free alcohol will therefore affect the price of smokeless powders for consumers other than the Government.

Of greatest importance, however, will be the use of tax-free alcohol for illuminating and heating purposes; it will displace the gasolene and coal oil which are now the universal liquid fuels. These petroleum products are now controlled by a trust, the Standard Oil Company, and there has been a steady rise in the price of these commodities from year to year. President Roosevelt, in his last message, says: "The Standard Oil Co. has, largely by unfair or unlawful methods, crushed out competition. It is highly desirable that an element of competition be introduced by the passage of some such law as that which has already passed the House, putting alcohol for use in the arts and manufacturies on the free list." Since the President wrote this, the free alcohol bill passed both House and Senate and received his signature.

Free alcohol will surely prove a most effective element of competition, and it is hard to understand how any trust or monopoly can ever control it. It is not pumped from wells in certain parts of the country, but can easily be made from a great variety of materials of practically unlimited supply in many parts of the country.

Alcohol will displace petroleum products and coal gas for

illuminating purposes; in countries where alcohol is tax-free it is now successfully used for lighting purposes. The Auer alcohol lamp, it is claimed, produces a cheaper and better light than coal oil. Experiments with alcohol and kerosene as to candle power and cost have shown that alcohol at 31 cents per gallon is cheaper for illuminating purposes than kerosene at 15 cents per gallon; this becomes still more important when we consider that kerosene costs more than 15 cents per gallon and is going up in price from year to year, while it is expected that with the development of the alcohol industry, the alcohol will be produced for less than 31 cents per gallon. An expert of the Department of Agriculture, speaking of the use of alcohol in Germany, says, in "The Gas Engine:" For lighting purposes, as alcohol gives a non-luminous flame, a chemical mantle similar to a Welsbach burner, is used, which produces a very bright and economical light, costing but one cent per hour for 71 candle power. In a report of Mr. Payne, of the Ways and Means Committee of the House of Representatives, it is stated that experiments have been made comparing an alcohol Welsbach lamp with the most approved pattern of kerosene lamps with round wicks and of equal candle power it was found that a gallon of alcohol would burn twice as long as a gallon of kerosene; if, therefore, alcohol costs less than twice as much as kerosene, it is the cheaper material for illuminating purposes, not considering its other advantages, such as absence of odor, greater safety and cleanliness.

Another important use of alcohol will be as a fuel, displacing wood, coal, coal gas, natural gas, and the various petroleum products. The question of a cheap and efficient fuel is of considerably greater importance than is usually believed; the supply of wood, coal and gas is limited, the demand for them is increasing; a substance must be found as a substitute, and in the near future. Tax-free alcohol will be such a substitute, the raw materials for which can be produced from year to year according to the demand for it. The fuel question is especially important in the western part of the United States, where the supply of soft coal is becoming low and hard coal is too expensive on account of the great cost of transportation from the source of supply in the East.

Alcohol is a more efficient fuel than the petroleum products

and has many other desirable advantages; it is a much cleaner substance to use, does not have as disagreeable an odor, and is burned completely more readily than petroleum products; its products of combustion are less disagreeable, it is less dangerous to handle, it is more safely shipped and stored, and most important of all, it is less volatile and less dangerous when used than petroleum products.

In cities, natural and manufactured gases are used extensively for heating; besides the advantages already mentioned, alcohol has the advantage over gaseous fuel that it can not become poisonous and that there is no expense of laying pipes and gas fitting, no interruptions in supply on account of repairs or accidents, and no danger from leaks, which, in the case of gas, are responsible for hundreds of deaths each year.

A most important use of alcohol will be its use in power engines. Many experiments have been made and it has been shown that alcohol can be used instead of gasolene, and with many advantages. Although the heat of combustion of alcohol is less than that of gasolene, yet it is claimed that twice as large a percentage of heat can be utilized and converted into work than can be done from gasolene; there is less heat thrown off in the waste gases from the combustion of an alcohol vapor and air mixture than there is in those from gasolene vapor and air mixture.

Mr. Goebbels, who is connected with a company making gas engines, states that they have made experiments to adapt alcohol for use in gas engines, and that 20% more power can be obtained from alcohol than from gasolene. Other experiments have shown that alcohol vapor and air forms a more perfect and reliable explosive mixture than gasolene vapor and air; the latter mixture is subject to spontaneous combustion and apt to explode prematurely on compression, and there is greater liability of incomplete combustion. Experiments are now being made in every country to adapt and perfect gas engines for the use of alcohol as a substitute for gasolene. In the earlier forms of alcohol engines alcohol alone could not be used, but a mixture of alcohol and gasolene, generally about 25% of the latter in the mixture, was found to work to advantage, this mixture being more readily ignited.

Extensive experiments are being made in England with al-

cohol motors for agricultural purposes; alcohol engines are especially adapted for supplying stationary power on farms, for pumping water, cutting and grinding feed, threshing and many other operations. As a motive fuel for agricultural implements, alcohol will supply the need for the Western farmer who lives too far from the supply of coal or other fuel, and who needs a great amount of power for his large farms and crops.

Summarizing the advantages of alcohol over other fuels we have the following:

It is cheaper, more reliable and efficient.

It is much cleaner to handle and use.

There is no danger from poisoning like there is in the use of natural or manufactured gases.

It does not have any disagreeable odor and its products of combustion are not objectionable.

It is less volatile and less dangerous to use, handle and store. Everybody is acquainted with the dangers of gasolene; insurance companies increase cost of, or refuse, insurance when gasolene comes into consideration.

An alcohol fire can be easily put out with water, since the latter readily mixes with alcohol in all proportions; a gasolene or oil fire can not be quenched with water; the latter only scatters the burning material.

When gasolene or oil leaks or is spilled it becomes dangerous and disagreeable and can be removed only with difficulty. Alcohol can easily be removed with water.

WHAT IS MEANT BY THE WORD ARTESIAN

The significance of the term "artesian" is discussed with great care by Mr. Myron L. Fuller of the United States Geological Survey in Water-Supply and Irrigation Paper No. 160. While there is considerable diversity of practice there is nevertheless a general tendency to give the term one or the other of two meanings, and about fifty geologists throughout the country have expressed their willingness to accept any definition agreed on by the majority of active workers on underground-water problems.

Discussing the original use of the term artesian (as applied to flowing wells first observed in the town of Artois, France), the use of the word in recent scientific literature, in Europe, and the present scientific and popular use of the term in this country, Mr. Fuller makes clear that no definite meaning can be assigned to the word artesian in a publication unless a defi-

nition is given in the same paper. It is even found that the same writer employs it differently in different publications.

The predominant scientific usage of the term is for all wells in which the water rises; in other words, for those exhibiting the hydrostatic or artesian principle. In popular practice it is applied, in addition to the uses previously mentioned, to deep wells in general, especially those in rock, and to a certain extent to any drilled wells yielding water of good sanitary quality.

After discussing the arguments for these various uses, Mr. Fuller gives the following definitions which were agreed on by the members of the Division of Hydrology of the Survey as the most expedient at the present time.

Artesian principle.—The artesian principle, which may be considered as identical with what is often known as the hydrostatic principle, is defined as the principle in virtue of which water confined in the earth's crust tends to rise to the level of the water surface at the highest point from which pressure is transmitted. Gas as an agent in causing the water to rise is expressly excluded from the definition.

Artesian pressure.—Artesian pressure is defined as the pressure exhibited by water confined in the earth's crust at a level lower than its static head.

Artesian water.—Artesian water is defined as that portion of the underground water which is under artesian pressure and will rise if encountered by the well or other passage affording an outlet.

Artesian system.—An artesian system is any combination of geologic structures, such as basins, planes, joints, faults, etc., in which waters are confined under artesian pressure.

Artesian basin.—An artesian basin is defined as a basin of porous bedded rock in which, as a result of the synclinal structure the water is confined under artesian pressure.

Artesian slope. An artesian slope is defined as a monoclinal slope of bedded rocks in which water is confined beneath relatively impervious covers owing to the obstruction of its downward passage by the pinching out of the porous beds, by their change from a pervious to an impervious character, by internal friction, or by dikes or other obstructions.

Artesian area.—An artesian area is an area underlain by water under artesian pressure.

Artesian well.—An artesian well is any well in which the water rises under artesian pressure when encountered.

PRODUCTION OF PIG IRON IN 1905.

Twenty States in the Union produced pig iron in 1905. The total production of pig iron in 1905 was 22,992,380 long tons. This is an increase in quantity of 6,495,347 long tons, or over 39 per cent. over the production of 1904. It is an increase in value from $233,025,000 to $382,450,000, amounting to $149,425,000, or 64.12 per cent. The average price per long ton of pig iron increased from $14.13 in 1904 to $16.63 in 1905.

(Stated Meeting, held Thursday, May 10, 1906.)

Observations on the Yellow Modification of Molybdic Acid.

By John Howard Graham.

Department of Chemistry, Central High School, Philadelphia.

[Investigations have shown that the yellow crystalline substance depositing from solutions of ammonium molybdate is of composition $H_2MoO_4 . H_2O$. It was noticed as early as 1876, identified in 1882, and a crystal measurement made in 1903. The following is an extract from the paper as presented.—The Editor.]

Recently, while transferring ammonium molybdate solution from a stock bottle to smaller reagent bottles, I noticed on the bottom of the former, a yellow crystalline incrustation, and there were some loose crystals. There is scarcely a chemist who has not noticed a yellow, yellowish-white or white deposit under similar conditions; but I have never observed one so uniformly yellow and homogenous; and my curiosity led me to the following investigation, the results of which, I think, should prove of interest to everyone handling such solutions.

I removed as much of the crust as I could, crushed it carefully, so as to expose the individual crystals, and then washed with pure water to remove adhering solution. The material was then air-dried. Whenever I had noticed the deposits from solutions of ammonium molybdate, without any good reasons for my doing so, I considered them basic or acid ammonium molybdates, that is, salts in which either ammonia or molybdic acid predominates. With such views in mind, qualitative tests were made with the following results:—

The yellow substance is very sparingly soluble in water, and the aqueous solution decomposes on concentration, affording

a bulky white precipitate, very soluble in ammonia, and this ammoniacal solution deposits on evaporation, white crystals of the molybdates of ammonia, several, because as many kinds of crystals were observed. The white precipitate is undoubtedly molybdic anhydride. Another sample of our material was found insoluble in nitric acid, as might be suspected from the fact that it deposits after continuous standing from solutions strongly acidified with nitric acid. The aqueous solution is decomposed by nitric acid giving the same milky white precipitate which I consider molybdic anhydride. It is very soluble in hydrochloric acid, in fact excessively so, making the solution syrupy. Heated very gently, it yields water; at a higher temperature it turns bluish in color, and if the heating is continued without air access, it becomes yellow and finally white when cold, and shows indications of incipient sublimation. When heated to redness it sublimes completely, the sublimate having all the appearances of pure molybdic anhydride. The results so far could easily have been obtained with any ammonium molybdate. The question suggested itself: Does it contain any ammonia? A rather large sample of the material was boiled with strong caustic soda. I thought I noticed ammonia. Test paper impregnated with mercurous nitrate solution, just turned faintly brown. My conclusions were, that if the substance was a molybdate, it must be of a very acid character. Examined under the objective of a microscope magnifying 85 diameters, the crystals appeared clear, well defined and prismatic. They were so small that I could not make out whether they were of the isometric or the monoclinic system. Later I obtained larger crystals and upon examining them, placed them in the monoclinic system.

With the foregoing facts in hand, literature was searched with the hope that light would be thrown upon the subject. We looked up molybdates, of course, and found nothing that would agree with our substance even qualitatively. A great number of molybdates of ammonia were described by Kämmerer* (1850) and Delafountaine† (1865), the information in many cases being meagre and uncertain. It might be of in-

*Journ. prakt. Chem. Series 1-xlix-445 (1850).
†Journ. prakt. Chem. Series 2-xcv-136 (1865).

terest to note, that Kämmerer estimated molybdic anhydride by reducing with hydrogen to constant weight, and weighing the molybdenum dioxide; also, by heating the salt with air access, adding drops of hydrochloric acid from time to time, and finally weighing the molybdic anhydride. The ammonia was determined by the well-known soda-lime method, the evolved gas being collected in hydrochloric acid and finally weighed as platinum.

The next most logical proceeding was to determine the composition of the substance by estimating water, molybdic anhydride and ammonia. The method used by Kämmerer and suggested by Fresenius, that of reduction by hydrogen, was used. Fresenius says, to use a porcelain boat in a hard glass tube, and that the temperature should not exceed a dull redness. I tried this. The water of crystallization passed over at a very low temperature, and, unless this is increased, no more water comes over. Heating to a dull redness, water resulting from the reduction of the molybdic oxide passes over. At the end of about two hours, the reaction has ceased. The material has suffered various changes of color, yellow to orange, to blue, to black, and to steel grey.

Rammelsberg* states that the contents of the crucible are frequently grey below and brown above. What I obtained was uniformly grey, and the weighings of the supposed molybdenum dioxide gave percentages of molybdenum trioxide as follows:

60.97; 61.12; 60.53; 61.55; 61.95; 61.82; 61.02; 61.64.

Having taken all proper precautions, yet the results were anything but concordant. My attention was next given to the ammonia content. Samples of one gram of material each were thoroughly mixed with finely divided soda-lime, and heated in the usual combustion tube for that purpose. The ammonia was collected in hydrochloric acid and was to have been determined as platinum. From two determinations I obtained such slight traces of the double chloride of platinum and ammonium that I had to consider the ammonia as a negligible trace. I was greatly surprised. I attributed the traces of ammonia to ammonium nitrate occluded in the

*Pogg. Annal. cxxvii-281; Zeitscher. f. anal. Chem. v-203.

crystals, and made the ferrous sulphate and dephenylamine tests for nitric acid. The former was altogether unsuccessful, for the former salt immediately reduced the solution and gave the intense blue due to the lower oxides of molybdenum. With the other reagent I first obtained a blue, due I think to nitrates, and after a time the solution became intensely blue, due again I think to reduction of the tri-oxide of molybdenum. Undoubtedly the ammonia is present in small traces as nitrate. So my yellow substance contains no ammonia in its composition. This directs me upon a new course. As to the water content, two samples of material heated in covered porcelain crucibles, with flames about one inch high and barely touching the bottom, gave results as follows by difference:—

20.07% and 20.03%

The ammonium molybdate solution from which the material was deposited, was purchased from Baker & Adamson and guaranteed pure. There could be present in the yellow substance therefore, no base but ammonia, and no acids other than nitric and molybdic acids. Since ammonia and nitric acid are present only in traces, we can consider them out of the question. The material therefore, should contain nothing but molybdic acid and water, both of which were found and estimated. If the water is present by 20%, there should be 80% of molybdic anhydride. How shall we account for the discrepancy between 61% about, as determined, and 80% theoretical? It could be possible that the contents of the boat were overheated. The supposed molybdenum dioxide did look too gray when compared with the color by which it has been described,—brown to black. It looked exactly like the metal molybdenum itself and it is possible to obtain the metal under these conditions. In order to see if I could get a different result by regulating the temperature more carefully, I heated a sample by stages intending to stop the operation when I obtained constant weight. With a very low flame I obtained a result which calculated for molybdic anhydride gave 85.05%. The height of the flame was then increased so as to have it just touch the tube. The percentage dropped to 78.77. Evidently the crucial point was again overstepped. The following three determinations were made with the flame not quite touching the tube—a Bunsen flame of about 1½

inches. The contents of the boat after cooling were uniformly dull black and homogenous throughout.

Result:—79.93%; 79.73%; 80.00%, the mean of which is 79.93%, and this added to the mean of the water determinations 20.05%;—gives 99.93%, corresponding to the formula $MoO_3.2H_2O$, or $H_2MoO_4.H_2O$.

References to this substance are few, yet they furnish substantially what I have enumerated above. I did not conceive of the substance being a modification of molybdic acid or I should have discovered earlier that the ground had practically been covered by others.

In the year 1876 Junck* observed the yellow deposit. He thought it was a metameric form of molybdic acid resulting from the action of light upon the solution. He made several experiments along this line.

Sergius Kern† took notice of the deposit and published notes concerning it in 1878.

In 1882 Millingk‡ makes mention that the yellow precipitate is $MoO_3.2H_2O$ and gives a meagre description, adding that it is soluble 0.5 gram about in one litre of water.

Parmentier,§ 1882, makes quite a thorough study of it and his observations as to its physical and chemical properties and composition agree quite closely with mine. The results of his analyses are:—

H_2O	19.96	19.95	19.94
MoO_3	80.04	80.05	80.06

Parmentier mentions that the crystals are monoclinic in form and in 1888 Vivier|| confirmed this statement.

It was not until 1903 that the final work upon the substance was done. De Schulten¶ prepared the yellow material according to the methods of Parmentier, acknowledging and confirming all his statements. He puts his solutions aside for years so as to obtain crystals large enough for measurement, and when he obtained some measuring 0.9 mm., 0.8 mm., and

*Zeit. anal. Chem. xv-290.

†Idem xvi-52.

‡Handbuch Gmelin-Kraut 2(2) clxx-1882.

§Comptes Rendus 839, 1882.

||Comp. Rend. cvi-601 (1888).

¶Bulletin French Min. Soc. xxvi-6, 1903.

0.8 mm. respectively along the axes a, b and c, he uses them for this purpose. In his paper reporting the work, he makes a drawing of one of the crystals, which shows the following forms:—

Positive and negative pyramids and orthodomes; two prisms; clino-dome; ortho-and clino-pinacoids and basal plane. The angle between the basal plane and the ortho-pinacoid is 89.19°, making the crystals appear at first glance as though they were cubes. They are clear and the faces are good reflectors.

Yellow molybdic acid is so far an unimportant substance, a mere chemical curiosity, but yet its manner of formation and its occurrence are of interest, and it deserves that we know its properties sufficiently well to be able to identify it.

THE PAN-AMERICAN RAILWAY.

The report of the committee on a railroad connecting North and South America, appointed at the Pan-American Conference in Mexico in 1902, has been submitted to the Pan-American Conference at Rio Janeiro. The committee considers that a railroad 10,400 miles long to connect New York with Buenos Ayres is feasible. Railroads already in existence or projected could be utilized, and it is reckoned that not more than 3700 miles of intercontinental railroad is now specifically provided for. This is divided as follows: Peru, 1200 miles; Ecudor, 450 miles; Colombia, 845 miles; Panama and Central America, 1200 miles. The route proposed is through Mexico into Central America, and along the slope of the Andes into Argentina. Branches to the seacoast, where the road runs through the interior, or into the interior, where the main line follows the coast, are contemplated.—*Iron Age.*

PRODUCTION OF MANGANESE IN 1905.

The production of manganese ores decreased from 11,995 long tons, valued at $116,722, in 1901, to 7,477 long tons, valued at $60,911 in 1902, and to 2,825 long tons, valued at $25,335 in 1903, and increased to 3,146 long tons, valued at $29,466 in 1904, and to 4,118 long tons, valued at $36,214 in 1905.

Section of Photography and Microscopy.

(Stated meeting held Thursday, December 6, 1906.)

Pictorial Composition for Beginners in Photography.*

By J. W. Ridpath, Vice-President of the Section.

Pictorial photography is a very broad subject. It deals with selection of subject, grouping, composition, light and shadow, focusing, making of negative and after treatment of the same, printing and mounting, each being a separate step toward the finished picture. For the present purpose it is intended to speak briefly upon only one branch of the subject.

Pictorial composition is based upon certain well established and generally accepted rules, or general principles, which, although somewhat elastic, are found to be generally observed by artists everywhere. Some say art is subject to no set rules, for its variations are infinite; yet nearly all agree that it has certain general principles. In fact, almost all pleasing pictures, whether paintings, drawings, etchings, photographs, or made by any other process, are found to be based upon some of these rules.

In a short article like this, it is only possible to refer briefly to a few of the more important or fundamental rules of composition, omitting such subjects as lighting, atmosphere, balance, &c. A careful observance of the following nine rules will greatly aid the young photographer in making more pleasing and consequently better pictures:

1. In selecting a subject to photograph there is always a principal object, that which you want a picture of. It should, if possible, be placed to one side of the center and below or above the middle line. In other words, place the principal object in one of the natural quarters of the picture space. The principal object should, if possible, be supplemented by one of lesser importance as a secondary object. If the view contains

*The paper was illustrated with the aid of a large number of lantern photographs appropriately selected to elucidate the points dwelt upon by the speaker.

trees, a position may be selected where a handsome or picturesque tree will occupy a point near the camera, in or near the foreground, as the principal object. This might be supplemented by a small tree of somewhat similar shape in the middle distance. A group of men or women might be supplemented by a group of children placed at a little distance. A church or other important building, in perspective, might be supplemented by a smaller building in another part of the picture.

2. Objects should be few in number and simple in character. A group of two or three trees looks much better than one showing an extensive and elaborate collection of shrubbery. The latter may look beautiful to the eye, but the former will yield a more pleasing picture. One shock of corn, well to the front, with a few others less distinctly shown in the distance, is much better than a number of shocks, equally spaced, at nearly the same distance from the camera. Two or three figures may be satisfactorily grouped, but to make a picturesque group of a dozen will require artistic skill of a high order.

3. In order that your picture may look natural, the surroundings should always be in keeping with the principal object. To illustrate: A lumberman's or huntsman's camp may look well in the forest. A fisherman's boat and nets should be beside water. A wagon loaded with logs might appropriately be coming out of the woods. A farm team should be engaged at some regular farm work, with appropriate surroundings, such as ploughing, hauling grain, raking hay or any other usual farming operation. A quaint stone arch, or rustic bridge, may impress you favorably; if so, you will find that a willow tree, group of shrubbery, or even a bunch of tall weeds, if near the camera, will add greatly to the picturesque effect.

4. The principal forms of composition are three in number. The angular form may be illustrated by drawing an imaginary line diagonally from an upper to a lower opposite corner; thus dividing the picture space into two triangles. The principal object may be advantageously placed in the lower triangle; the secondary object may be placed in the lower half of the upper triangle as middle distance, while the upper half of the upper triangle is occupied by the sky or other background. Sometimes a very handsome angular grouping is effected by placing the principal object in the upper triangle of the picture space with the secondary object in the lower triangle.

5. The pyramidal form of grouping is particularly good for strong objects; being shaped like a mountain it gives an idea of stability. The tall tree, church-tower, a house in perspective or tallest man in a group, occupying a somewhat central and commanding position a little to the right or left of the center of the picture space, might form the basis of a good strong composition.

6. The circular or oval forms are light and graceful and lend themselves naturally to groups of shrubbery or flowers, and still-like objects, curved or radiating forms, are quite plentiful in nature. The dependant branches of the elm and willow, the oval form of the violin, many articles of glass and porcelain, the spray from a fountain, a vase filled with flowers, the oval form of the human face and indeed the long oval of the human frame, are illustrations of this graceful form of composition.

You do not always find objects that compose readily; perhaps the fault is in the objects themselves; perhaps it is the wrong time of day, or time of year; conditions are not always alike. Change your position slightly and look again. If the image on the ground glass is not pleasing, why expose a plate?

7. It is important that the principal lines of the picture be so placed as to enhance its beauty, otherwise they may detract from it. Generally the horizon or sky-line in out-door pictures should be placed about one-third distance from the top or the bottom, not half-way up. In many cases the sky-line is quite important. A gently undulating background with hazy distance, being suitable for peaceful farm scenes. Rugged mountain scenery might appropriately have a saw-tooth or jagged sky-line.

8. All important lines, such as fences, roads, streams, &c., should lead into, not out of, a picture. They should be so placed as to lead the eye unconsciously toward some point of general interest. For the above reason a cross-roads picture is seldom pleasing. If the important lines conform to Hogarth's line of beauty, a graceful double curve, they will greatly enhance the beauty of your picture.

9. Figures, if included in a landscape or other view, should always be appropriate in character, and in keeping with the surroundings. A farmer at work in the fields, dressed in his working clothes, is more picturesque than the same man in his best bib and tucker entertaining company on the front porch.

A hod carrier would look better with a pipe in his mouth, than smoking a cigarette. Two girls in sunbonnets, picking blackberries, might add life to the scene; but two young ladies dressed in silk and lace, wearing ostrich plumes in their hats, would be out of place among blackberry briars. Perhaps there is no more certain way to spoil an otherwise good picture, than to pose your cousin or best girl in the picture center, with nothing to do but stare at the camera. If you must place her in the range of the lens, give her some appropriate employment, such as picking daisies, golden rod, or other wild flowers, but if you value her friendship, don't have her looking at the camera. To do so will probably spoil the composition, and the portrait is almost sure to be disappointing.

Some persons may object that these rules, or general principles, are not practical; that many views cannot be artistically grouped. It is certainly true that many views are quite commonplace, having nothing picturesque in them. In an afternoon's outing the camerist may pass a hundred views, many of which have some attractiveness; but only one or two appeal to him. While you cannot move the wayside cottage or trees, you can move the camera. Select the most important object and give it a strong place in the picture space, a little out of the center. Select a few objects, not too many, as accessories; most views contain too much. Try to find a suitable foreground. Move a little nearer or farther away; to the right or left; raise or lower your camera. While the principal object should occupy a strong place, the view should be considered as a whole, unity or oneness being all important. Examine the image on the ground glass and select the best viewpoint. If you spend a little time intelligently studying the scene, the chances are that you will secure a much better picture than you could by a "hit or miss" method. Remember that one good picture is worth more than ten poor ones.

The Franklin Institute.

Proceedings of the Stated Meeting held Wednesday, December 19th, 1906.

HALL OF THE INSTITUTE,
Philadelphia, December 19, 1906.

President JOHN BIRKINBINE in the chair.

Present, twenty-five members.

Additions to membership since last report, four.

Mr. Birkinbine made the following remarks in view of his contemplated retirement from the office of President, viz:

"To the Members of the Franklin Institute:

"In accepting the re-election of President last January, I expressed the intention to retire at the close of the Institute year, and therefore my name will not be presented for re-nomination.

"For ten successive years you have bestowed on me the highest honors which the Institute can offer a member, and this opportunity is taken to express warm appreciation of your confidence and support.

"The first President of the Institute served for 16 years, and the second for 14 years, but with these exceptions no one has presided over the Institute for a longer period than myself; a compliment of which I am justly proud.

"The decision to withhold my name as a candidate for President, is not due to unwillingness to perform the duties imposed by the office, nor to waning interest in the work which the Institute seeks to accomplish, nor to failure to appreciate the high honor of presiding over an organization whose fame is world wide, and which for eighty-two years has striven to advance science and the arts. On the contrary, if the matter is considered from a strictly selfish standpoint, it would be gratifying to continue in office.

"While no duty has been intentionally avoided in the decade just closing, the office demands from the President attention difficult to give by one upon whom active engineering duties make claims, especially as professional work requires repeated and extended absences from Philadelphia.

"Experience has demonstrated the importance of having the Institute presided over by one who could personally oversee the many details of its work, and by his presence inspire activity, hence, I believe, the action taken will be to the advantage of the Institute.

"A retrospect of what has been accomplished by the Franklin Institute in the past ten years, is gratifying, but the realization that it has been impossible to secure funds sufficient to insure rehabilitation of the Institute is a source of regret to myself, as it was to my predecessors. However, indications are now more favorable towards securing a new building and advanced facilities than ever before, and with the active support of all members this may become an assured fact during the administration of my successor.

"That an organization which has accomplished so much; which has rendered gratuitous service to city, state and nation, which has advanced so many inventions; which is honored in every country; which has an unexcelled technical library, and which has educated in its schools thousands who were unable to secure the advantage of technical instruction elsewhere, should be hampered in its efforts by insufficient funds, seems strange in the days when millions are devoted to younger, but not more useful organizations, and to the establishment of libraries far inferior to that of the Franklin Institute.

"In relinquishing the responsibilities and honor of the presidency, I urge upon all members and friends of the Institute united and persistent effort to secure sufficient endowment to erect, equip and care for a build-

ing which will permit of the Franklin Institute maintaining its work, free from the discouragements which have beset its management.

"Those who have served as my colleagues on the Board of Managers, have expressed a desire that I should continue a member thereof, and if this is your wish it will be my pleasure to support my successor and render service as a manager as a slight return for the honor which has been conferred on me."

At the close of the President's remarks the following preamble and resolution, offered by Prof. Lewis M. Haupt, and duly seconded, were unanimously adopted, viz:

"WHEREAS, The Institute learns with regret of the declination of its President for good and sufficient reasons to consent to a re-nomination for the ensuing year. It is therefore

"*Resolved*, That this meeting expresses its high sense of appreciation of the services rendered by Mr. John Birkinbine during the past ten years as an active and efficient President of this Institute.

"*Resolved*, Further, that a copy of above resolution be sent to the President as an expression of the good-will and appreciation of the members for the services rendered."

Prof. Haupt thereupon read a paper on "The Chesapeake and Delaware Canal," fully illustrated by means of lantern slides, in which he strongly advocated the importance of improving this water-way, in the interests of commerce.

The paper was discussed by Messrs. James Christie, Louis E. Levy, Henry F. Colvin and the author.

(The paper is referred for publication). The speaker received the thanks of the meeting for his able and interesting communication.

The following nominations for officers, managers and committeemen were made, to be voted for at the Annual Election to be held on Wednesday, January 16, 1907, between the hours of 4 and 8 o'clock p. m., to wit:—

For President	(to serve one year).....	WALTON CLARK.
" *Vice-President*	(" three years)..	HENRY HOWSON.
" *Secretary*	(" one year).....	WM. H. WAHL.
" *Treasurer*	(" ").....	SAMUEL SARTAIN *
" *Auditor*	(" three years)..	SAMUEL P. SADTLER.

For *Managers* (to serve three years).

STEPHEN GREENE, CHARLES A. HEXAMER, ALEX. KRUMBHAAR,
ALFRED C. HARRISON, HENRY R. HEYL, WALTER WOOD,
JOHN BIRKINBINE.

For *Managers* (to serve one year).

OTTO W. SCHAUM, E. H. SANBORN.

For *the Committee on Science and the Arts* (to serve three years).

JAMES CHRISTIE,	CHARLES A. HEXAMER,	SAMUEL SARTAIN,*
G. H. CLAMER,	WALDEMAR LEE,	FRANK SHUMAN,
J. LOGAN FITTS,	JACOB Y. M'CONNELL,	T. CARPENTER SMITH,
RICHARD W. GILPIN,	J. W. RIDPATH,	THOMAS SPENCER,
WM. O. GRIGGS,	LINO F. RONDINELLA,	WILLIAM H. THORNE,
FRANCIS HEAD,	ARTHUR J. ROWLAND,	J. C. TRAUTWINE, JR.,
WILHELM VOGT,	URBANE C. WANNER.	

Adjourned.

WM. H. WAHL, *Secretary.*

*Since deceased.